CHEMICAL AND PHYSICAL QUALITY OF WATER RESOURCES IN THE ST. LAWRENCE RIVER BASIN NEW YORK STATE

by

A. L. Mattingly

Published by the
New York State Department of Commerce,
cooperatively with the Geological Survey,
United States Department of Interior.

1961

Bulletin No. 4

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(1955-1956)

(Progress Report)

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U. S. GEOLOGICAL SURVEY

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PREFACE

In 1952, the U. S. Geological Survey in cooperation with the New York State Department of Commerce started a continuing program to appraise the chemical and physical qualities of the State's water resources. The objective of the program is to provide information that will be useful to those concerned with water and its use in industry, agriculture, recreation, and public water supply.

This progress report is the fourth in a series of reports on the chemical and physical qualities of water resources in selected areas of New York State. It covers preliminary results of a study of the chemical quality-of-water resources in the St. Lawrence River basin for the 1956 water year. Since then, the study has been broadened and additional data and information are being obtained. After completion of the current investigation, a comprehensive report will be prepared on the St. Lawrence River basin.

The cooperation of Harold Keller, Edward T. Dickinson, former Commissioners, Keith S. McHugh, present Commissioner

and Ronald B. Peterson, Deputy Commissioner, all of the New York State Department of Commerce, is gratefully acknowledged. Records of discharge were furnished by A. W. Harrington, former district engineer, and Donald F. Dougherty, present district engineer of the Surface Water Branch, and geologic data were furnished by Ralph Heath, district geologist, Ground Water Branch, Albany, New York. Chemical analyses were made by personnel of the Quality of Water Branch, Albany, New York. The program is under the general direction of S. K. Love, chief, and the immediate supervision of F. H. Pauszek, district chemist, Quality of Water Branch. All of the Branches mentioned above are organizational units of the Water Resources Division, U.S. Geological Survey.

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ABSTRACT

The chemical quality of the ground water and of the following major streams in the St. Lawrence River basin is discussed in this report: Black River at Watertown, Oswegatchie River at Heuvelton, Grass River at Pyrites and St. Lawrence River at Ogdensburg. Tables and illustrations supplement the discussion.

The bedrock of the area is composed of Precambrian crystalline rocks and sandstone and carbonate rocks of Cambrian and Ordovician ages. The minerals from these deposits, particularly the carbonate rocks, are relatively soluble. This is evident from the dissolved-solids content of most streams. With the exception of the St. Lawrence River at Ogdensburg, the dissolved-solids content of the streams generally ranged from 28 to 94 ppm, and the hardness of water ranged from 12 to 70 ppm. The dissolved-solids content of the St. Lawrence River ranged from 141 to 196 ppm and hardness of water ranged from 59 to 390 ppm.

The area has cold winters and cool summers. Year-round temperatures are in the general range of minus 45°F to plus 100°F, and the average annual temperature is about

42°F. The average annual precipitation is about 30 inches along the northern boundary and about 40 inches in the Adirondacks. The heaviest rainfall occurs during the summer. Snowfall ranges from about 60 inches at the lower altitudes, to about 140 inches in the Tug Hill Plateau. Much of the snow remains on the ground until late April or early May.

The climatic conditions are responsible for the variations in streamflow, which in turn affects the chemical and physical qualities of water from the streams. During high streamflow, dilution reduces the dissolved-solids content, and cooler water lowers the water temperature. During low flow, however, the dissolved-solids content is greater; dilution is less effective and the inflow of more mineralized water from ground storage adds to the solute content.

The chemical quality of water from most streams in the area is satisfactory for multiple uses but not necessarily for all uses. Iron concentrations in water from a few streams could be a problem. Generally, the hardness of water would present no problem.

A few chemical analyses of ground water resources in the St. Lawrence River basin are available. These show considerable variation in waters from different aquifers. The dissolved-solids content of water from limestone and dolomite deposits ranges from 236 to 1770 ppm and the hardness ranges from 153 to 601 ppm. In water from granite and sandstone, the concentrations of dissolved solids (computed) range from 277 to 458 ppm and the hardness from 221 to 345 ppm. Iron concentrations vary also irrespective of the source. The chemical quality of ground water is generally satisfactory but would be necessary to reduce iron concentrations and hardness of water from some sources.

INTRODUCTION

The hydrologic cycle is a term used to describe the natural circulation of water in, on, and above the earth. The cycle begins when water evaporates from the surface of the earth into the atmosphere. As the water vapor condenses, it falls back to the earth in the form of hail, rain, snow, or sleet. Even before reaching the earth's surface, some of the precipitation again evaporates into the atmosphere. Part of the precipitation that falls upon the earth is retained temporarily in the soil, in surface depressions, on vegetation, and on other objects. Eventually, it evaporates. Another part moves by various surface and underground channels to rivers, lakes, ponds, and, finally, into the sea where the cycle starts all over again.

The chemical quality of water has its origin in the atmospheric part of the hydrologic cycle. Clouds, rain, or snow, high above the earth's surface, are practically free from impurities. However, as rain or snow descends toward the earth, it dissolves oxygen, carbon dioxide, and other gases from the air, as well as dust, smoke, and even micro-organisms.

Upon reaching the earth's surface, water acquires additional elements from the rocks and soils. The quantity of mineral matter dissolved depends principally on the solubility of rocks and soils with which the water comes in contact and on the length of time of contact. Color, odor, and taste in water, to a large extent, are attributable to organic substances introduced into surface and ground water by runoff from cultivated land and by drainage from swamps, forests and ditches. Industrial and domestic wastes discharged into streams also contribute to these properties of water.

Overland runoff and ground water differ markedly in chemical quality. At any one time, a stream may contain only overland runoff, ground water, or a mixture. Accordingly, the chemical quality of water from a stream will depend on the contribution from each source.

The chemical quality of ponds, lakes, and reservoirs is affected by a turn-over effect that occurs in the spring and fall of each year. As the temperature of the top layer falls, water becomes denser. The denser layer sinks to the bottom and is replaced by warmer layers (maximum density of water occurs at approximately 39°F). As the temperature of

water is lowered from 39 to 32°F, the water expands and becomes lighter, and the bottom layer again rises to the top. This exchange of water layers creates a turbulent condition. Some of the deposited mineral matter is brought to surface. Here some of it dissolves, some remains in suspension and some settles again.

SURFACE - AND GROUND - WATER QUALITY DIFFERENCES

Surface water is the water that occurs in well defined channels and depressions on the surface of the earth (water in streams and lakes). It may be composed of ground water or of water that has moved over the surface in indistinct channels (overland runoff) from where it fell as precipitation. Water that sinks into the ground to be tapped by vegetation, to emerge as springs, or to be tapped by means of wells, shafts, or infiltration galleries, is termed "ground water."

Ground water moves slower than surface water and is in contact with the mineral matter of an area longer than surface water. Consequently, ground water may contain higher concentrations of mineral matter than surface water.

Ground water is generally clearer than surface water. The filtering and the adsorbing action of the rocks remove or reduce turbidity, color, and bacteria in water as it seeps slowly through the ground. Water in streams, on the other hand, seldom is exposed to environmental conditions that would reduce these physical and bacteriological characteristics.

Surface water, unless polluted by industrial wastes and mine drainage, rarely has a concentration of more than 1 part per million (ppm) of iron. Ground water on the other hand, commonly has concentrations of as much as 10 ppm of iron (Hem, 1959, p.65).

Natural water rarely has a fluoride concentration of 10 ppm or more although ground water from one source in Idaho is reported to have as much as 32 ppm of fluoride (Hem, 1959, p.113). Surface water seldom has a fluoride concentration of more than 1 ppm.

According to Hem (1959, pp.117-118), nitrate content in surface water, unless extensively polluted by sewage or other sources, seldom is as high as 5 ppm and often is less than 1 ppm. In ground water, however, the concentration may range from practically zero to nearly 1,000 ppm. High nitrate concentrations may be the result of organic pollution or the use of soluble nitrates or gaseous ammonia as fertilizers for crops.

According to Lohr and Love (1952,p.8), many natural surface-water supplies,especially lakes, have less than 5 ppm of silica. A few have more than 30 ppm. In contrast,

ground water generally has more silica than surface water, although the concentrations usually are less than 50 ppm of silica.

The pH range of most ground waters is somewhat different from that of surface water. Again according to Hem (1959, p.48), the pH of ground water in the United States generally ranges from about 5.5 to slightly more than 8. Water with a pH higher than 8 or less than 5.5 is found occasionally. In some places, particularly in humid regions, the pH of surface water is usually about 7, but that of most surface water generally is 7 to 8.

Whereas the temperature of surface water generally fluctuates with changes in air temperature, the temperature of ground water usually remains fairly constant throughout the year. According to Collins (1925,pp.97-104), the temperature of ground water, at depth from 30 to 60 feet, generally exceed by 2° to 3°F the mean annual temperature of the surrounding atmosphere. An increase of about 1°F may be expected for every 64 feet of additional depth (British Assoc. Adv. Sci., 1882, p.88).

According to the American Water Works Association's Manual (1951), hardness of ground water usually exceeds the

hardness of surface water of the region in which both occur. This is apparent in analyses of surface and ground waters from the St. Lawrence River plain; the hardness of surface water ranges from 12 to 390 ppm, whereas the hardness of ground water ranges from 50 to 601 ppm.

THE EFFECT OF CHEMICAL AND PHYSICAL QUALITY ON THE UTILITY OF WATER RESOURCES

The utilization of water resources depends, in part, upon their chemical qualities. The textile, paper and laundering industries require water that is soft, colorless and low in dissolved solids, especially low in iron and in manganese. Boilers that are operated above 400 psi (pounds per square inch) require water that has a hardness of 2 ppm or less (California State Water Pollution Control Board, 1952, p.267) and a silica content of 1 ppm or less (Rainwater and Thatcher 1960, p.259) is very desirable. The beverage and the canning industries require water that does not affect the taste and quality of the product. Table 1 gives some of the quality-of-water tolerances that have been established for certain industries. Table 2 lists the chemical constituents usually found in water, their occurrence, and their effects upon the water - user concerned. Many of these constituents were determined as a part of this study.

Water is an excellent heat-exchange medium. About one-third of the water used by industry is used for cooling purposes. Electric-power plants, oil refineries, steel

TABLE 1. - WATER QUALITY TOLERANCES FOR INDUSTRIAL APPLICATIONS 1/

Industry	Turbidity ppm.	Color ppm.	Color+ O_2 Consumed ppm.	D.O. ml./l	Odor	Hardness ppm.	Alkalinity ppm.	pH	Total Solids ppm.	Ca ppm.	Fe ppm.	Mn ppm.	Fe+ Mn ppm.	Al_2O_3 ppm.	SiO_2 ppm.	Cu ppm.	F ppm.	CO_3 ppm.	HCO_3 ppm.	OH ppm.	$CaSO_4$ ppm.	Na_2SO_4 to Na_2SO_3 ratio	General 2/
Air Conditioning 3/	—	—	—	—	—	—	—	—	—	—	0.5	0.5	0.5	—	—	—	—	—	—	—	—	—	A,B
Baking	10	10	—	—	—	4/	—	—	—	—	0.2	0.2	0.2	—	—	—	—	—	—	—	—	—	C
Boiler Feed:																							
0-150 psi.	20	80	100	2	—	75	—	8.0+	1000-3000	—	—	—	—	5	40	—	—	200	50	50	—	1 to 1	—
150-250 psi.	10	40	50	0.2	—	40	—	8.5+	500-2500	—	—	—	—	0.5	20	—	—	100	30	40	—	2 to 1	—
250 psi. and up	5	5	10	0	—	8	—	9.0+	100-1500	—	—	—	—	0.05	5	—	—	40	5	30	—	3 to 1	—
Brewing 5/																							
Light	10	—	—	—	Low	—	75	6.5-7.0	500	100-200	0.1	0.1	0.1	—	—	—	1	—	—	—	100-200	—	C,D
Dark	10	—	—	—	Low	—	150	7.0	1000	200-500	0.1	0.1	0.1	—	—	—	1	—	—	—	200-500	—	C,D
Canning																							
Legumes	10	—	—	—	Low	25-75	—	—	—	—	0.2	0.2	0.2	—	—	—	—	—	—	—	—	—	C
General	10	—	—	—	Low	—	—	—	—	—	0.2	0.2	0.2	—	—	—	1	—	—	—	—	—	C
Carbonated Beverages 6/	2	10	10	—	0	250	50	—	850	—	0.2	0.2	0.3	—	—	—	0.2	—	—	—	—	—	C
Confectionary	—	—	—	—	Low	—	—	—7/	100	—	0.2	0.2	0.2	—	—	—	—	—	—	—	—	—	—
Cooling 8/	50	—	—	—	—	50	—	—	—	—	0.5	0.5	0.5	—	—	—	—	—	—	—	—	—	A,B
Food, General	10	—	—	—	Low	—	—	—	—	—	0.2	0.2	0.2	—	—	—	—	—	—	—	—	—	C
Ice (Raw Water) 9/	1-5	5	—	—	—	—	30-50	—	300	—	0.2	0.2	0.2	—	10	—	—	—	—	—	—	—	C
Laundering	—	—	—	—	—	50	—	—	—	—	0.2	0.2	0.2	—	—	—	—	—	—	—	—	—	—
Plastics, Clear, Uncolored	2	2	—	—	—	—	—	—	200	—	0.02	0.02	0.02	—	—	—	—	—	—	—	—	—	—
Paper and Pulp:																							
Groundwood	50	20	—	—	—	180	—	—	—	—	1.0	0.5	1.0	—	—	—	—	—	—	—	—	—	A
Kraft Pulp	25	15	—	—	—	100	—	—	300	—	0.2	0.1	0.2	—	—	—	—	—	—	—	—	—	—
Soda and Sulfite	15	10	—	—	—	100	—	—	200	—	0.1	0.05	0.1	—	—	—	—	—	—	—	—	—	—
Light Paper, HL-Grade	5	5	—	—	—	50	—	—	200	—	0.1	0.05	0.1	—	—	—	—	—	—	—	—	—	B
Rayon (Viscose) Pulp:																							
Production	5	5	—	—	—	8	50	—	100	—	0.05	0.03	0.05	8.0	25	5	—	—	—	—	—	—	—
Manufacture	0.3	—	—	—	—	55	—	7.8-8.3	—	—	0.0	0.0	0.0	—	—	—	—	—	—	—	—	—	—
Tanning 11/	20	10-100	—	—	—	50-135	135	8.0	—	—	0.2	0.2	0.2	—	—	—	—	—	—	—	—	—	—
Textiles:																							
General	5	20	—	—	—	20	—	—	—	—	0.25	0.25	—	—	—	—	—	—	—	—	—	—	—
Dyeing 12/	5	5-20	—	—	—	20	—	—	—	—	0.25	0.25	0.25	—	—	—	—	—	—	—	—	—	—
Wool Scouring 13/	—	70	—	—	—	20	—	—	—	—	1.0	1.0	1.0	—	—	—	—	—	—	—	—	—	—
Cotton Bandage 13/	5	5	—	—	Low	20	—	—	—	—	0.2	0.2	0.2	—	—	—	—	—	—	—	—	—	—

1/ American Water Works Assn., Water Quality and Treatment, Table 3-4, water quality tolerance, industrial applications, page 67, 1950.
2/ A-No corrosiveness; B-No slime formation; C-Conformance to federal drinking water standards necessary; D-NaCl, 275 ppm.
3/ Waters with algae and hydrogen sulfide odors are most unsuitable for air conditioning.
4/ Some hardness desirable.
5/ Water for distilling must meet the same general requirements as for brewing (gin and spirits mashing water of light beer quality; whiskey mashing water of dark-beer quality).
6/ Clear, odorless, sterile water for syrup and carbonization. Water consistent in character. Most high quality filtered municipal water not satisfactory for beverages.
7/ Hard candy requires pH of 7.0 or greater, as low value favors inversion of sucrose, causing sticky product.
8/ Control of corrosiveness is necessary as is also control of organisms, such as sulfur and iron bacteria, which tend to form slimes.
9/ $Ca(HCO_3)_2$ particularly troublesome. $Mg(HCO_3)_2$ tends to greenish color. CO_2 assists to prevent cracking. Sulfates and chlorides of Ca, Mg, Na should be less than 300 ppm. (white butts).
10/ Uniformity of composition and temperature desirable. Iron objectionable since cellulose absorbs iron from dilute solutions. Manganese very objectionable, clogs pipelines and is oxidized to permanganates by chlorine, causing reddish color.
11/ Excessive iron, manganese or turbidity creates spots and discoloration in tanning of hides and leather goods.
12/ Constant composition; residual alumina 0.5 ppm.
13/ Calcium, magnesium, iron manganese, suspended matter and soluble organic matter may be objectionable.

Table 2. - Common constituents in water

CHEMICAL CONSTITUENTS	OCCURRENCE	EFFECT	USER CONCERNED
Silica (SiO_2)	Found in all natural waters in varying concentrations. Ground waters, generally, contain more silica than surface waters.	Forms boiler scale and deposits on turbine blades.	Industry
Iron (Fe) and Manganese (Mn)	In practically all natural waters. Generally, smaller amounts are found in surface waters than in ground waters.	Concentrations of about 0.3 part per million or more stain laundry, porcelain fixtures and other materials.	Industry and public
Calcium (Ca) and Magnesium (Mg)	In all natural waters. Highest concentrations found in water in contact with limestone, dolomite, and gypsum.	Soap consuming. Forms an insoluble curd and deposits in pipes and boiler tubes.	Industry and public water supplies
Sodium (Na) and Potassium (K)	In all natural waters. In very low concentrations of alkalies, concentrations of sodium and potassium are about equal. As concentrations of alkalies increase proportion of sodium increases.	Large amounts may cause foaming in boiler operation. In irrigation waters, large amounts degrade the soil.	Industry, public water supplies, and agriculture
Bicarbonate (HCO_3)	In all natural waters. Larger concentrations present in waters in contact with decaying organic matter, and carbonate rocks.	Large amounts may affect taste of drinking water. Large quantities in combination with sodium degrade the soil.	Industry, public water supplies, and agriculture

Table 2. - Common constituents in water (Cont.)

CHEMICAL CONSTITUENTS	OCCURRENCE	EFFECT	USER CONCERNED
Sulfate (SO_4)	Present in most natural waters. Larger amounts in waters in contact with gypsum and shale.	In conjunction with calcium and magnesium forms permanent hardness and hard scale in boiler operation.	Industry and public water supplies
Chloride (Cl)	Present in most natural waters. Larger amounts in contaminated waters.	Taste of drinking water affected when amounts of more than about 250 ppm are present. Corrosiveness is also increased.	Industry and public water supplies
Fluoride (F)	Present in most natural waters in small concentrations.	About 1.0 ppm believed to be helpful in reducing incidence of tooth decay in small children. Believed to cause mottled enamel on teeth at higher concentrations. (Lohr and Love (1952, p.39).	Public water supplies
Nitrate (NO_3)	Present in most natural waters. Contamination by sewage and organic material increases quantity present.	Small amounts have no effect. Forty-four ppm or more reported to produce methemoglobinemia in infants. May indicate pollution.	Public water supplies

mills and foundries are only a few of the users of water for cooling purposes. Both ground and surface waters are used as cooling water. However, chemical characteristics being equal, ground water is more suitable because its temperature throughout the year is usually low and constant. Unfortunately, ground water is often too expensive to be obtained in adequate amounts. For example, large electric-power plants will use 500,000 gallons of water per minute (about 1,000 cubic feet per second) or more for surface condenser operations. Such volumes usually are more economically obtained from surface sources. But, the temperature of surface water usually approximates air temperature and is subject to seasonal fluctuations. Thus, at times, cooling towers are used to lower the temperature.

GENERAL FEATURES OF THE AREA STUDIED IN THE ST. LAWRENCE RIVER BASIN

The northwest boundary of the St. Lawrence River basin in New York State, as here considered, fronts on the St. Lawrence River and extends southeast deep into the foothills of the Adirondack Mountains, which include the northern half of the county of St. Lawrence and adjoining corners of the counties of Jefferson and Franklin (Plate 1).

Physiographically, this region generally is one of low relief. Periodic glaciation has been an important factor in modifying the region. It presents a sharp contrast to the mountainous region in the east.

The bedrock of the St. Lawrence region consists of approximately equal areas of Precambrian crystalline rocks, and sandstone and carbonate rocks of Cambrian and Ordovician age. The Precambrian rocks have been intensely folded, faulted, and transformed, whereas Cambrian and Ordovician rocks of the area have been gently folded. Faults have been found, and probably many more are concealed by the unconsolidated deposits. The Ordovician and Cambrian rocks may be regarded as a comparatively thin mantle of nearly horizontal

layers overlying the Precambrian rock (Plate 2).

With the exception of the St. Lawrence River, which flows in a northeast direction, most streams within the province flow northwest in parallel courses. As the streams emerge from the floor of the valley, their flow patterns change before the streams flow into the St. Lawrence River. The courses of these streams are believed to have been fashioned by the periodic advances and recessions of glaciers.

The climate of the area is characterized by cold winters and cool summers. The average annual temperature is about 42°F with extremes ranging from minus 45°F to plus 100°F. The average annual precipitation along the northern boundary is about 30 inches whereas the average precipitation in the Adirondacks is about 40 inches. The heaviest rainfall occurs during the summer months. Snowfall generally ranges from 60 inches, at the lower altitudes, to 140 inches in the Tug Hill Plateau. Much of the snow remains on the ground until late April or early May.

Climatic data collected by the U. S. Weather Bureau at stations in and near the area are summarized in tables 3 and 4. Plate 4 shows the average annual precipitation for the

area.

Because of the precipitation the average annual over-land runoff ranges from 14 to 130 inches (plate 3). Stream-flow records are summarized in table 5.

All of the physical characteristics of the basin either directly or indirectly play an important role in determining the chemical quality of natural water. The relationship of some of these physical characteristics and chemical quality of water sources in the St. Lawrence River basin is discussed in the following pages.

Table 3. - Mean monthly temperature
St. Lawrence River basin

(Degrees Fahrenheit)

Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Alexandria Bay	18.2	20.6	30.6	43.3	56.0	65.4	70.9	69.7	61.3	50.4	38.6	24.2
Boonville	--	--	--	--	--	--	--	--	--	--	--	--
Canton	16.6	15.8	27.8	41.9	54.2	63.5	68.6	66.5	58.8	47.5	35.0	21.8
Chasm Falls	16.7	15.7	28.0	39.8	53.0	62.4	67.0	64.5	57.2	46.2	33.2	19.2
Dannemora	16.6	16.6	27.2	40.1	53.7	63.0	68.0	65.9	58.6	47.1	33.4	20.4
Gouverneur	15.8	17.8	29.8	42.9	55.5	65.0	59.9	68.2	58.9	48.4	36.5	21.7
Lawrenceville	16.9	17.1	28.6	42.1	55.9	65.2	70.0	68.2	60.3	48.5	35.3	20.1
Lowville	18.2	18.6	28.7	42.3	54.4	63.3	67.9	65.4	58.3	46.8	34.8	22.4
McKeever	14.3	14.9	25.5	38.4	52.3	60.5	65.3	63.4	55.2	44.5	31.9	18.9
North Lake	16.1	15.7	25.4	38.2	51.1	60.3	65.3	63.8	56.8	45.4	32.5	20.4
Ogdensburg	16.9	17.6	28.7	43.3	55.7	65.1	70.1	68.1	61.2	49.5	36.3	22.3
Old Forge	17.2	15.2	25.2	39.4	52.6	59.0	64.8	62.0	55.9	46.5	32.9	21.4
Raquette Lake	15.5	14.9	26.2	39.0	52.1	61.0	65.4	63.2	56.8	45.7	31.6	19.5
Stillwater Reservoir	14.1	13.5	24.4	37.3	51.9	60.5	65.4	63.3	56.6	44.8	32.1	17.9
Tupper Lake	15.8	15.2	26.5	38.4	51.8	60.2	64.9	62.4	55.7	44.8	32.1	19.3
Wanakena	16.1	15.8	26.2	39.2	52.5	60.7	65.1	63.0	56.1	45.6	33.1	20.7
Watertown	20.5	20.3	30.9	44.1	56.3	65.7	70.5	68.7	61.8	49.9	37.6	24.6

Table 4. - Average monthly and annual precipitation,[1] in inches, at and near chemical quality sites in the St. Lawrence River basin

Location	Years of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Alexandria Bay	19	2.92	2.57	3.00	3.07	2.99	2.80	3.49	2.69	3.53	3.12	3.42	3.32
Boonville	29	3.62	3.02	3.56	3.30	3.54	3.28	3.87	3.56	4.16	4.06	3.92	3.80
Canton	73	2.59	2.25	2.58	2.51	3.04	3.33	3.67	3.30	3.41	3.05	3.09	2.71
Chasm Falls	18	2.75	2.38	2.71	3.73	3.81	3.59	4.52	3.35	3.72	3.27	3.53	3.07
Dannemora	30	2.54	2.28	2.59	2.96	3.28	3.62	3.74	3.07	3.37	2.76	2.71	2.76
Gouverneur	47	2.42	2.14	2.35	2.25	2.76	2.73	3.02	2.35	3.24	3.38	2.94	2.48
Lawrenceville	20	1.83	1.68	2.09	2.82	3.28	3.24	3.66	3.10	3.30	3.01	2.61	2.32
Lowville	95	2.95	2.69	2.59	2.58	3.01	3.33	3.30	3.18	3.03	3.48	3.48	3.26
Massena	12	1.60	1.68	1.90	2.45	3.38	2.32	3.92	2.32	2.88	2.57	2.78	2.70
McKeever	20	3.92	2.91	3.60	3.98	3.90	3.76	4.46	4.05	4.74	4.58	4.19	3.83
North Lake	36	4.54	3.85	4.43	3.75	4.10	4.53	4.79	4.04	4.61	4.51	4.43	4.33
Ogdensburg	62	2.12	2.03	2.35	2.27	2.83	3.09	3.17	2.74	2.78	2.72	2.62	2.27
Old Forge	14	4.41	4.42	3.81	3.61	4.25	4.15	4.28	3.81	4.15	3.74	4.51	4.22
Raquette Lake	49	3.54	3.05	3.52	3.23	3.73	4.00	4.38	3.47	4.08	3.80	3.91	3.80
Stillwater Reservoir	30	4.33	3.33	4.23	4.17	4.03	4.16	4.90	4.12	4.39	4.64	4.62	4.48
Tupper Lake	42	2.55	2.31	2.67	2.32	3.23	3.70	4.32	3.66	3.57	3.43	2.83	2.54
Wanakena	42	3.18	2.66	3.38	3.10	3.37	3.57	4.10	3.53	3.88	4.04	3.57	3.11
Watertown	63	3.16	2.63	2.95	2.83	3.40	3.15	3.36	3.19	3.72	3.82	3.77	3.50

1/ Includes snowfall

Table 5. - Streamflow data,

St. Lawrence River basin 1/

Location	Average Discharge Years	cfs
Black River near Boonville	1925-56	684
Middle Branch Moose River at Old Forge	1912-56	105
Middle Branch Moose River near McKeever	1925-56	328
Moose River at McKeever	1907-13, 1914-56	837
Independence River at Donnattsburg	1942-56	199
Beaver River at Croghan	1930-56	576
Deer River at Copenhagen	1929-56	223
Black River at Watertown	1920-56	3,926
East Branch Oswegatchie River near Oswegatchie	1925-56	526
West Branch Oswegatchie River near Harrisville	1916-56	513
Oswegatchie River near Heuvelton	1916-56	1,699
St. Lawrence River at Ogdensburg 2/	1860-1956	241,000
Grass River at Pyrites	1924-56	604
Raquette River at Piercefield	1908-56	1,287
Raquette River at Raymondville	1944-56	2,053
St. Regis River at Brasher Center	1910-17, 1919-56	1,061

Table 5. - Streamflow data (Cont.)

St. Lawrence River basin 1/

Location	Average Discharge Years	cfs
Salmon River at Chasm Falls	1925-56	229
Chateaugay River near Chateaugay	1926-56	178
Great Chazy River at Perry Mills	1928-56	272
Saranac River at Plattsburg	1903-30, 1943-56	839
West Branch Ausable River near Newman	1919-56	220

1/ Records of discharge for water year October 1955 to September 1956 given in U. S. Geol. Water-Supply Paper 1437.

2/ From official records of the U. S. Lake Survey, Corps. of Engineers, U. S. Army, and the counterpart Canadian Agencies.

CHEMICAL AND PHYSICAL QUALITIES OF SURFACE WATERS IN THE ST. LAWRENCE RIVER BASIN

St. Lawrence River at Ogdensburg, N.Y.

The St. Lawrence River flows for 120 miles along the northern boundary of New York State where it forms the international boundary between the United States and Canada. Beginning at Tibbetts Point at the eastern end of Lake Ontario and extending for about 40 miles to Chippewa Point the river is dotted with more than 1,700 islands, the Thousand Islands. Hundreds of other islands are no more than tiny reefs, but others are large. Hamlets and beautiful estates have been located on these islands. From Ogdensburg, the beginning of the International Rapids Section, which is now part of the St. Lawrence Seaway, the river flows northeast and leaves the United States near Massena Point. It then sweeps around the island of Montreal, flows past Quebec, and enters the Gulf of St. Lawrence. Between Lake Ontario and tidewater, near Quebec, the river descends 246 feet.

At Ogdensburg, the St. Lawrence River has a drainage area of approximately 295,000 square miles, including the

drainage area of the Oswegatchie River. The bedrock of this area consists of dolomite. In many areas, the dolomite is overlain by unconsolidated deposits of till, sand and gravel, and clay.

CHEMICAL QUALITY

Because a large percentage of the flow of the St. Lawrence River at Ogdensburg comes from Lake Ontario, the chemical composition of the river at Ogdensburg should be similar to that of the water from Lake Ontario. A review of chemical quality data shows that this assumption is correct. For example, table 6 shows the close similarity of the chemical composition of the St. Lawrence River at Ogdensburg, and at Alexandria Bay, an extension of Lake Ontario. Also, the chemical composition of the St. Lawrence River at Ogdensburg is similar to that of Lake Ontario at Rochester. From table 6, it is apparent that calcium and bicarbonate are the predominant ions of the water, both at Ogdensburg and at Alexanderia Bay.

Lake Ontario, despite the variety in the quality of the water entering from both the American and Canadian drainage basins, maintains a relatively constant composition throughout the year.

The dissolved-solids content of 26 composite water samples taken from the St. Lawrence River during the 1956 water year ranged from 141 to 196 ppm. The time-weighted average of these samples was 179 ppm (table 7). Using the

Table 6.-Analyses of miscellaneous water samples

(Chemical constituents, dissolved solids and hardness in parts per million. Analyses by U. S. Geological Survey, United States Department of the Interior)

Sample number	Pa 12948 1/	NYE546 1/	NYE547 2/
Date of Collection	4/26/55	8/17/55	8/18/55
Silica (SiO_2)	1.5	1.7	2.6
Iron (Fe)	.03	.10	.02
Manganese (Mn)	.01	.00	.00
Calcium (Ca)	33	38	36
Magnesium (Mg)	6.2	7.9	7.8
Sodium (Na)	14	9.1	9.0
Potassium (K)	1.6	1.3	1.3
Bicarbonate (HCO_3)	108	113	110
Carbonate (CO_3)	0	0	0
Sulfate (SO_4)	27	24	24
Chloride (Cl)	22	21	20
Fluoride (F)	.1	.0	.0
Nitrate (NO_3)	.7	.7	.8
Dissolved-solids (Residue on evaporation at 180°C)	183	170	165
Hardness (Ca+Mg)	108	128	122
Noncarbonate hardness as $CaCO_3$	20	35	32
Specific conductance (micromhos at 25°C)	297	301	294
pH	8.1	8.0	8.1
Color	3	5	7

1/ St. Lawrence River at Alexandria Bay, N. Y.
2/ St. Lawrence River at Ogdensburg, N. Y.

Table 7.--Analyses of water from the St. Lawrence River at Ogdensburg, N. Y.

LOCATION.--At end of pier, just above U. S. Lighthouse, Odgensburg, N.Y., St. Lawrence County.
DRAINAGE AREA.--298,100 square miles, approximately, including that of Oswegatchie River.
RECORDS AVAILABLE.--Chemical analyses: October 1955 to September 1956.
Water temperature: October 1955 to September 1956.
EXTREMES, 1955-56.--Dissolved solids: Maximum, 196 ppm Apr. 21-30; minimum, 141 ppm Mar. 21-23, 25-31.
Hardness: Maximum 390 ppm Jan. 31; minimum, 59 ppm June 5,6.
Specific conductance: Maximum, 868 micromhos Jan. 31; minimum, 143 micromhos June 5, 6.
Water temperature: Maximum, 73°F Aug. 18-20; minimum, freezing point on many days during December, January, February and March.
REMARKS.--Records of specific conductance and pH of daily samples in district office at Albany, N. Y. Records of discharge for water year October 1955 to September 1956 given in Water-Supply Paper 1437.
Discharge records which have been coordinated with counterpart Canadian Agencies furnished by U. S. Lake Survey, Corps of Engineers, U. S. Army.

(Chemical constituents, dissolved solids, hardness in parts per million, 1956 water year)

Date of collection	Mean discharge (thousands of cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color	Oxygen consumed	
														Calcium, magnesium	Non-carbonate				Unfiltered	Filtered
Oct. 1-10,1955	251	3.8	0.06	38	8.0	9.8	1.5	114	26	22	0.0	0.8	173	128	34	306	7.5	4	5.5	2.2
Oct. 11-20	252	4.6	.04	38	9.0	10	1.5	111	--	22	.0	.4	--	132	41	315	7.8	5	--	--
Oct. 21-31	259	3.8	.04	38	7.9	9.7	1.5	115	25	21	.0	.8	174	127	33	304	7.5	5	10	2.4
Nov. 1-10	259	5.9	.03	34	9.9	11	1.4	113	26	22	.1	.9	186	126	33	314	7.6	4	6.0	2.9
Nov. 11-16,18,20	256	4.8	.03	38	9.2	9.7	1.4	115	--	22	.0	.2	--	133	38	306	7.9	5	--	--
Nov. 21-30	255	4.1	.12	38	7.7	10	1.4	114	25	21	.1	.8	183	126	33	312	7.5	4	3.4	2.0
Dec. 1-10	249	4.1	.03	38	8.2	10	2.4	117	--	23	.0	.6	--	129	33	310	7.6	3	--	--
Dec. 11-20	252	1.1	--	38	7.9	9.6	1.2	118	--	22	.1	.9	--	127	31	310	7.8	4	--	--
Dec. 21-31	246	1.6	.04	34	7.6	15	1.6	105	--	21	.0	1.1	--	116	30	285	7.2	3	--	--
Jan. 1-10, 1956	238	3.0	.05	37	8.8	9.6	1.4	108	28	22	.1	1.1	175	129	40	305	7.3	2	7.3	2.9
Jan. 11-20	238	3.2	.08	37	7.3	10	1.4	116	--	22	.0	1.2	--	122	27	302	7.5	3	--	--
Jan. 21-30	239	5.2	--	38	10	10	1.4	112	28	22	.1	1.0	180	136	44	309	7.6	2	4.5	2.8
Jan. 31	238	--	--	--	--	--	--	368	--	66	--	2.9	--	390	88	868	7.2	--	--	--
Jan. 21-31	--	--	.19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Feb. 1	238	--	---	--	--	--	--	266	--	44	--	2.0	--	280	62	632	7.4	--	--	--
Feb. 2-8, 10	236	3.2	--	36	8.2	9.9	1.5	114	25	22	.2	1.1	176	124	30	307	7.6	3	5.0	2.6
Feb. 1-10	--	--	.07	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Feb. 11-17,19-20	235	4.7	--	29	7.6	8.1	1.4	98	--	16	.2	1.0	--	104	23	258	7.6	5	--	--
Feb. 18	236	--	--	--	--	--	--	57	--	6.0	--	1.5	--	62	15	165	7.4	--	--	--
Feb. 11-20	--	--	.14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Feb. 21-29	232	5.0	.12	30	7.0	8.2	1.5	90	25	16	.2	2.0	150	104	30	231	7.7	3	3.8	3.0
Mar. 1-10	234	3.5	.02	34	9.2	9.8	1.5	109	25	21	.2	1.3	168	123	33	290	7.7	3	5.4	3.8
Mar. 11-20	238	5.0	.12	32	7.7	8.0	1.5	101	--	18	.2	1.1	--	112	29	273	7.6	5	--	--
Mar. 21-23,25-31	242	5.2	--	28	6.8	7.0	1.3	89	23	14	.2	1.3	141	98	25	238	7.5	3	6.2	4.3
Mar. 24	239	--	--	--	--	--	--	67	--	9.5	--	1.8	--	75	20	188	7.2	--	--	--
Mar. 21-31	--	--	.07	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Apr. 1	246	--	--	--	--	--	--	85	--	13	--	1.4	--	91	21	225	7.3	--	--	--
Apr. 2-10	248	6.8	--	37	7.9	9.8	1.5	113	26	22	.1	1.3	183	125	32	302	7.8	3	4.4	2.8
Apr. 1-10	--	--	.03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Apr. 11-20	260	1.2	.01	37	7.9	9.7	1.2	118	--	22	.1	.7	--	125	28	307	7.7	3	--	--
Apr. 21-30	263	3.9	.07	37	9.2	10	1.3	120	26	21	.1	.7	196	130	32	316	7.6	3	4.2	2.2
May 1-8	269	2.4	--	38	9.1	9.2	1.2	118	24	22	.1	1.4	182	132	36	315	7.8	2	3.7	2.6
May 9-10	272	--	--	--	--	--	--	74	--	13	--	1.4	--	84	23	202	7.6	--	--	--
May 1-10	--	--	.12	--	--	--	--	--	--	--	--	--	--	--	--	--	---	--	--	--
May 11-20	278	2.6	.11	38	7.6	9.7	1.2	119	--	22	.1	.6	--	126	29	309	7.9	2	--	--
May 21-31	282	3.5	.04	37	9.0	9.2	1.4	116	23	21	.2	1.3	177	129	34	305	7.9	2	4.7	3.2
June 1-4,7-10	284	3.0	--	37	7.5	9.5	1.6	114	24	20	.0	1.3	178	123	30	292	7.6	3	7.2	3.2
June 5,6	286	--	--	--	--	--	--	54	--	4.0	--	1.6	--	59	15	143	6.9	--	--	--
June 1-10	--	--	.07	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
June 11-13,15-20	281	3.3	--	38	6.7	9.4	1.3	112	21	22	.1	1.4	181	122	31	299	7.6	3	5.0	3.6
June 14	284	--	--	--	--	--	--	67	--	5.4	--	1.9	--	80	25	165	6.8	--	--	--
June 11-20	--	--	.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 7.-Analyses of water from the St. Lawrence River at Ogdensburg, N. Y. (Cont.)

(Chemical constituents, dissolved solids, hardness in parts per million, 1956 water year)

Date of collection	Mean discharge (thousands of cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color	Oxygen consumed: Unfiltered	Oxygen consumed: Filtered
June 21,23-30,1956..	279	2.2	--	38	7.9	9.5	1.5	113	24	24	0.0	1.4	179	127	35	309	7.8	4	3.7	3.4
June 22.............	279	--	--	--	--	--	--	80	--	9.0	--	2.4	--	84	18	197	7.3	--	--	--
June 21-30..........	--	--	0.08	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
July 1-10...........	275	4.7	.09	38	8.2	11	1.5	117	24	23	.0	1.2	187	128	33	313	7.8	4	3.5	2.6
July 11-20..........	274	2.6	.02	38	8.1	9.5	1.4	117	23	24	.1	1.3	187	128	32	313	7.8	4	3.6	2.6
July 21-31..........	273	4.1	.03	39	8.1	9.6	1.3	115	24	24	.1	.6	181	131	36	310	7.7	4	3.7	3.4
Aug. 1-10, 1956.....	269	2.4	.14	39	7.6	10	1.5	114	26	23	.0	1.8	189	129	35	309	7.7	4	6.3	3.0
Aug. 11-20..........	266	2.4	.08	39	7.8	10	1.4	114	26	23	.1	1.8	184	129	36	307	7.7	4	3.9	3.0
Aug. 21-31..........	261	1.8	.10	37	9.9	10	1.4	116	24	23	.1	.7	179	133	38	308	7.7	3	--	--
Sept. 1.............	260	--	--	--	--	--	--	81	--	14	--	.9	--	96	30	218	7.0	--	--	--
Sept. 2-10..........	263	3.4	--	37	8.3	9.5	1.6	111	24	22	.1	.7	173	127	36	301	7.4	2	4.6	2.7
Sept. 1-10..........	--	--	.17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sept. 11-20.........	261	3.2	.21	36	9.0	10	1.6	112	28	22	.1	.8	175	127	35	300	7.4	3	4.8	3.6
Sept. 21-30.........	255	2.6	.26	35	8.1	9.5	1.7	110	23	22	.1	.7	169	121	31	297	7.6	3	4.2	4.0
Time-weighted average	257	3.5	0.09	36	8.2	9.7	1.5	112	25	21	0.1	1.0	179	125	33	299	--	3	5.0	3.0
Maximum		6.8	0.26	39	10	15	2.4	368	28	66	0.2	2.9	196	390	88	868	7.9	5	10	4.3
Minimum		1.1	.01	28	6.7	7.0	1.2	54	21	4.0	0.0	0.2	141	59	15	143	6.8	2	3.4	2.0

equation:

$$\text{Approximate dissolved solids (ppm)} = 21 + (0.52 \times \text{specific conductance in micromhos at } 25^{\circ}\text{C})$$

developed from the relationship of dissolved solids and specific conductances, estimated daily dissolved solids were computed (fig.1). These computations show that the dissolved solids in water from the St. Lawrence River equalled or exceeded 199 ppm only 5 percent of the time and 50 percent of the time the dissolved-solids content equalled or was less than 185 ppm (table 8).

Figure 2 shows fluctuations in water quality of the St. Lawrence River with time and discharge; specific conductance was used as an index of water quality.

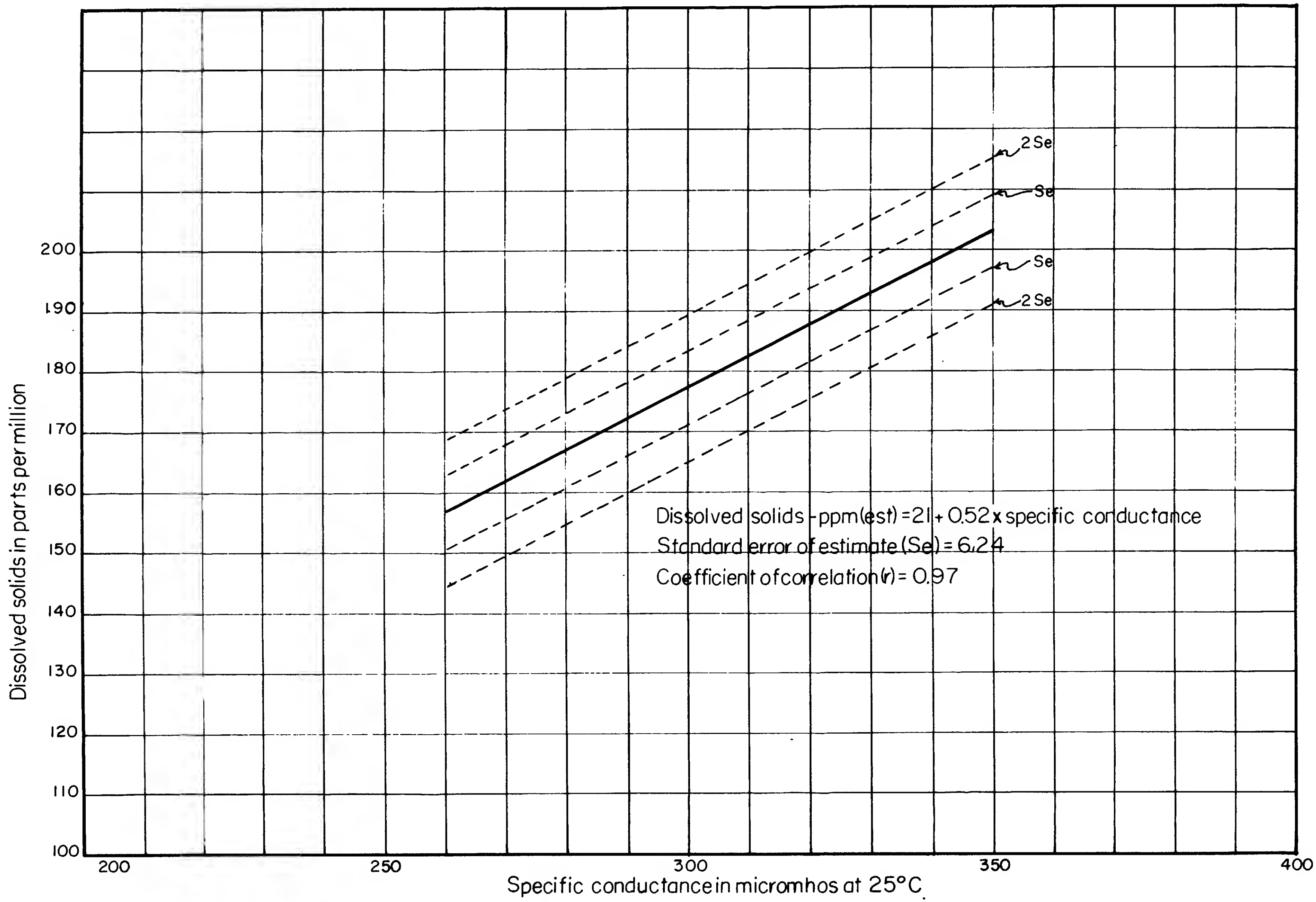

Figure 1.- Dissolved solids and specific conductances,
St. Lawrence River at Ogdensburg, N.Y.
1956 water year.

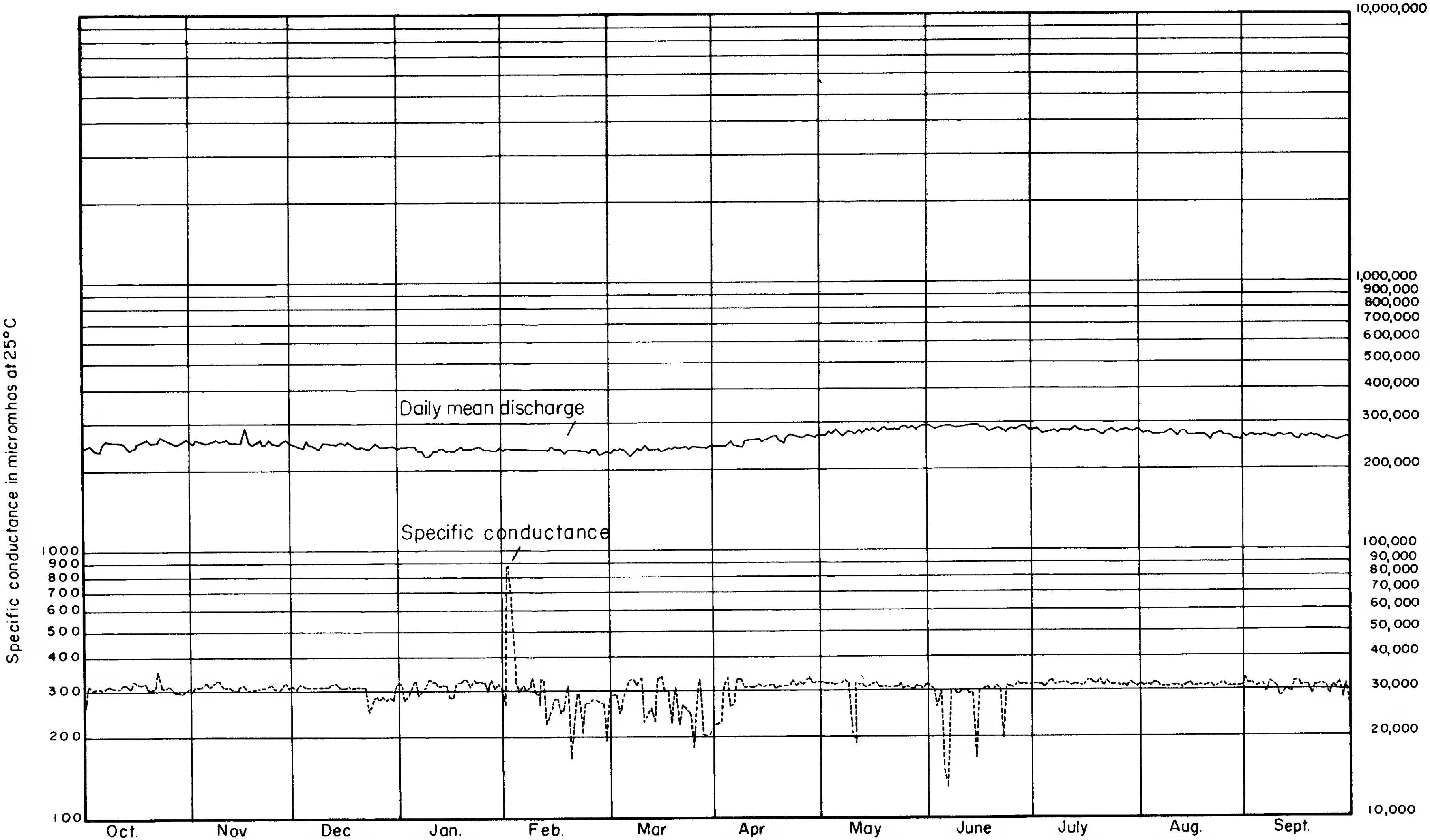

Figure2- Specific conductance and daily mean discharge, St. Lawrence River at Ogdensburg, N.Y.
1956 water year

Table 8 - Percent of days in which dissolved-solids content tabulated was equalled or exceeded in water from the St. Lawrence River at Ogdensburg, 1956 water year.

	Percent						
	5	10	25	50	75	95	99
Dissolved-solids content (ppm)	199	197	192	185	172	130	103

Estimated from frequency of specific conductance and 26 composite water analyses relating specific conductance to dissolved solids.

Calcium plus magnesium constituted about 27 percent of the dissolved solids (time-weighted average adjusted by converting bicarbonate to carbonate equivalent). Concentrations of calcium ions ranged from 28 to 39 ppm, and those of magnesium ions ranged from 6.7 to 10 ppm. The time-weighted average concentration of each ion was 36 ppm and 8.2 ppm respectively.

Hardness of water is attributable principally to calcium and magnesium ions. In the St. Lawrence River at Ogdensburg hardness of water ranged from 59 to 390 ppm and equalled or exceeded 138 ppm 5 percent of the time (table 9).

Table 9 - Percent of days in which tabulated values of hardness as $CaCO_3$ were equalled or exceeded in water from the St. Lawrence River at Ogdensburg, 1956 water year.

	Percent					
	5	20	50	75	95	99
Hardness as $CaCO_3$ (ppm)	138	135	130	120	92	67

Estimated from frequency of specific conductance and analyses relating specific conductance to hardness as $CaCO_3$.

Concentrations of sodium and potassium ions ranged from 7.0 to 15 ppm and 1.2 to 2.4 ppm, respectively; the time-weighted average of each ion was 9.7 and 1.5 ppm, respectively.

The bicarbonate ion was the predominate anion in the water from the St. Lawrence River at Ogdensburg; because of the relative abundance of carbonate minerals in the area. The bicarbonate concentration ranged from 54 to 368 ppm with a time-weighted average of 112 ppm.

Concentrations of sulfate ions ranged from 21 to 28 ppm and those of chloride ranged from 4.0 to 66 ppm. The time-weighted average concentration of each was 25 and 21 ppm. Undoubtedly, the gypsum and halite deposits in the Erie-

Ontario Plain are responsible for a large share of the sulfate and chloride ions in the St. Lawrence River at Ogdensburg.

Fluoride and nitrate ions were present in the water in only minor quantities, less than 0.3 and 3.0 ppm each.

The pH of the water generally fluctuated between 6.8 and 7.9. Once in December 1955 and again in June 1956, the pH dropped below 6.8. In October 1955 and at several other times during the period from May to August 1956, the pH exceeded 7.9.

POLLUTION

Data from the NENYIAC (New England-New York Inter-Agency Committee) report (1954) indicates that the most polluted section of the river between Alexandria Bay and Waddington was in the vicinity of Ogdensburg. This section was polluted by sewage and industrial wastes. Fluctuations in the chemical quality of the river are attributed, in part, to this sewage and industrial pollution. Higher discharges also may have been effective in reducing the pollution load and its effect on the chemical quality of the St. Lawrence River. However, after proper treatment the water would be suitable for some recreational and agricultural purposes and for public water supply.

WATER TEMPERATURE

The average water temperature of the St. Lawrence River at Ogdensburg during the water year October 1955 to September 1956 was 49°F. Early in October 1955, the water temperature began to drop steadily until it finally reached freezing temperature (32°F) in late December. From December 1955 to the early part of March 1956, the water temperature remained near freezing. During the spring thaw in April, the temperature began to rise gradually then rose steadily throughout the late spring and summer to a maximum of 73°F in mid-August (fig. 3 and table 10).

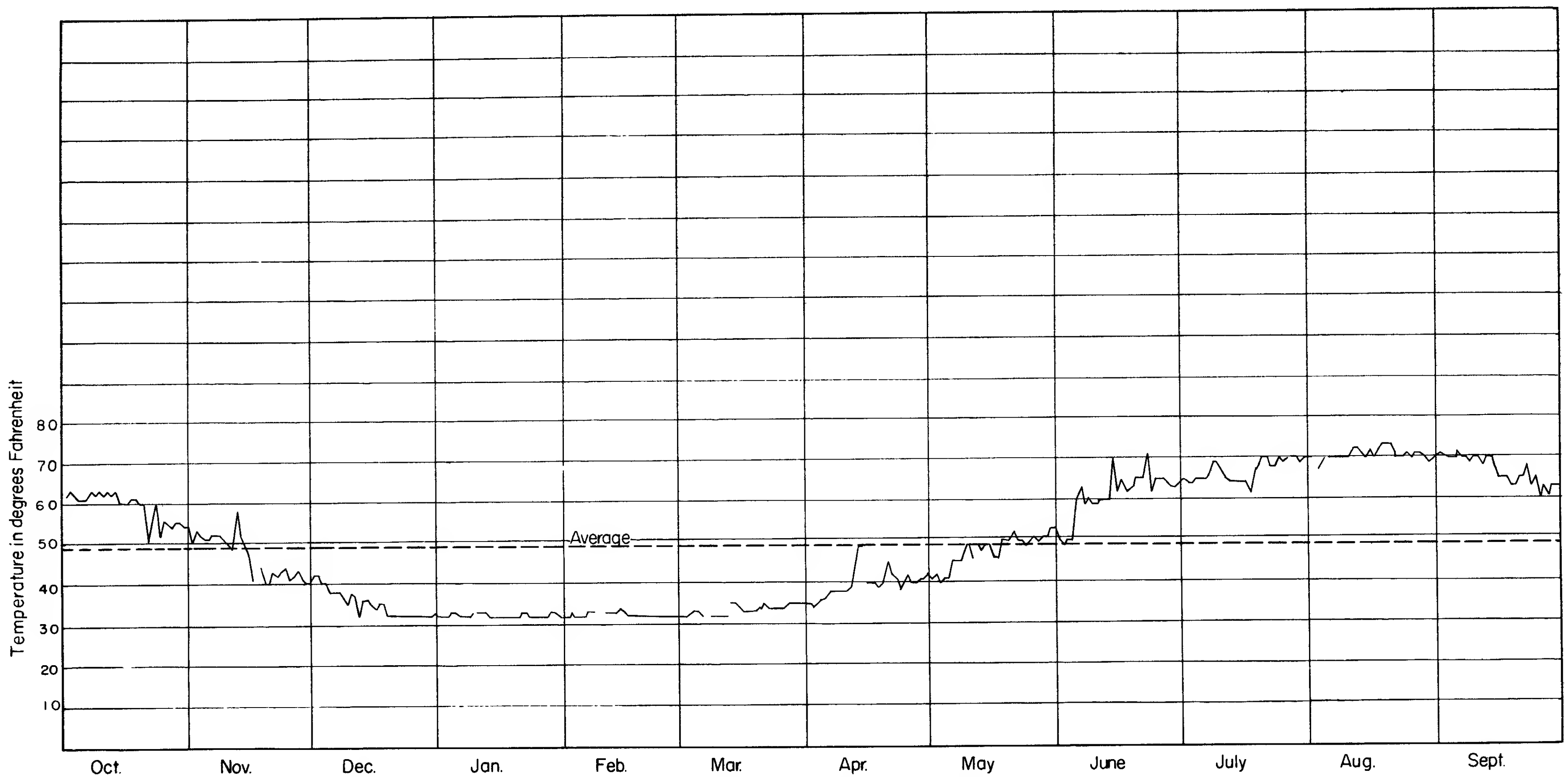

Figure 3.- Daily water temperature in degrees Fahrenheit, St. Lawrence River at Ogdensburg, N.Y.
1956 water year

Table 10.-Daily water temperatures of the St. Lawrence River at Ogdensburg, N.Y.

Temperature (°F) of water, 1956 water year

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	62	50	42	32	32	32	35	41	50	65	70	71
2	63	53	42	32	33	32	34	42	49	64	—	70
3	62	52	40	32	32	—	35	40	50	64	68	70
4	61	51	40	33	32	33	36	41	50	65	70	70
5	61	51	38	33	32	33	36	41	60	65	70	71
6	61	52	38	32	32	32	38	45	63	65	70	70
7	63	52	38	32	33	—	38	45	59	66	70	70
8	62	52	37	32	33	32	38	45	60	69	70	69
9	63	50	35	33	—	32	38	49	59	69	70	70
10	62	50	38	33	33	32	38	49	59	67	70	70
11	63	49	37	33	33	32	39	46	60	65	72	68
12	62	58	32	33	33	32	43	49	60	64	72	70
13	63	52	36	32	33	35	49	48	60	64	71	70
14	60	50	36	32	34	35	49	49	70	64	70	68
15	60	47	35	32	33	34	40	49	62	64	72	65
16	60	41	34	32	32	33	40	46	65	64	70	65
17	61	—	35	32	32	33	40	46	62	68	72	65
18	61	44	35	32	32	33	39	50	63	67	73	63
19	60	40	32	32	32	33	40	50	65	68	73	63
20	60	40	32	32	32	34	45	50	65	70	73	65
21	51	43	32	33	32	35	42	52	65	70	70	65
22	55	42	32	33	32	34	41	50	71	68	70	68
23	60	43	32	32	32	34	39	50	62	68	70	63
24	52	44	32	32	32	34	40	49	65	70	71	65
25	56	41	32	32	32	34	42	50	65	69	70	60
26	55	42	32	32	32	34	40	51	65	70	71	63
27	54	43	32	32	32	35	40	50	64	70	71	60
28	55	41	32	33	32	35	41	51	63	70	70	63
29	55	40	32	33	32	35	41	51	63	69	69	63
30	54	40	32	32	—	35	42	53	64	70	69	63
31	54	—	32	32	—	35	—	53	—	70	70	—
Average	59	47	35	32	32	34	40	48	61	67	71	67

SUMMARY

The chemical quality of the St. Lawrence River at Ogdensburg, is similar to that of Lake Ontario. This is natural, for most of the water in the river comes from Lake Ontario. The dissolved-solids content of the river ranged from 141 to 196 ppm. Hardness of water ranged from 59 to 390 ppm. The pH generally ranged from 6.8 to 7.9. The water temperature of the river fluctuated as the ambient air temperature varied. Sanitary quality data show that the most polluted section of the river between Alexandria Bay and Waddington was in the vicinity of Ogdensburg. However, specific effects of pollution upon chemical quality are not known. With proper chemical treatment, water from the St. Lawrence River at Ogdensburg can be adapted for industrial, agricultural, and public water-supply purposes. The type of treatment used will depend upon the particular use to be made of the water.

Oswegatchie River at Heuvelton, N. Y.

The Oswegatchie River is the outlet of Partlow Lake located in the Adirondacks at an altitude of about 1,750 feet above mean sea level. The river, formerly called the East Branch, follows a meandering northerly course and is dammed at several places to form ponds and lakes. Cranberry Lake, with a storage capacity of 2.5 billion cubic feet, is the largest of these bodies of water.

The West Branch of the Oswegatchie River rises in Buck Pond in the northwestern part of Herkimer County and flows in a northerly direction until it joins the Oswegatchie River near Talcville. At the gaging station near Heuvelton, the total drainage area is 973 square miles. Parts of the area lie in St. Lawrence, Lewis, Herkimer, and Hamilton counties and the northwestern slopes of the Adirondack Mountains. The Oswegatchie River flows into the St. Lawrence River at Ogdensburg.

The bedrock in the basin consists of Cambrian sandstones and Precambrian crystalline rocks overlain by unconsolidated deposits of sand, till, and gravel. Generally, these rocks are only slightly soluble and contribute but small amounts of mineral matter to the streams.

Table 11.-Analyses of water from the Oswegatchie River at Heuvelton, N.Y.

LOCATION.--At bridge, about 0.3 mile from power plant, Heuvelton, St. Lawrence County and about 2½ miles downstream from gaging station.
DRAINAGE AREA.--973 square miles at gaging station (above gaging station)
RECORDS AVAILABLE.--Chemical analyses: October 1955 to September 1956.
Water temperatures: October 1955 to September 1956.
EXTREMES, 1955-56.--Dissolved solids: Maximum, 93 ppm Oct. 21-31; minimum, 64 ppm July 21-31.
Hardness: Maximum, 260 ppm Jan. 8; minimum, 35 ppm Mar. 11-20.
Specific conductance: Maximum, 496 micromhos Jan. 8; minimum, 86.0 micromhos April 11-20.
Water temperatures: Maximum, 78°F Sept. 9; minimum, 33°F on many days during December, January, February and March.
REMARKS.--Records of pH and specific conductance of daily samples available in district office in Albany, N.Y. Records of discharge for water year October 1955 to September 1956 given in Water-Supply Paper 1437. Inflow from Lisbon Creek and several smaller tributaries contributes to discharge at sampling point.

(Chemical constituents, dissolved solids, and hardness in parts per million, 1956 water year)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color	Oxygen consumed: Unfiltered	Oxygen consumed: Filtered
Oct. 1-10, 1955	488	4.2	0.28	12	4.2	6.3	1.2	40	22	4.8	0.0	0.6	77	47	15	126	7.5	12	6.2	4.0
Oct. 11-20	800	7.6	.31	14	4.3	5.5	1.4	40	--	4.2	.7	.8	--	53	20	132	7.2	15	--	--
Oct. 21-31	1,310	6.7	.27	15	3.9	3.8	1.5	40	26	3.8	.0	1.0	93	54	21	142	7.3	27	14	6.2
Nov. 1-10	1,400	7.4	.27	15	3.8	3.0	1.0	34	26	3.5	.1	.8	89	53	25	131	7.4	27	11	6.9
Nov. 11-20	993	6.1	.31	14	5.8	3.3	.8	34	--	2.8	.0	.9	--	59	31	117	7.2	27	--	--
Nov. 21-30	1,060	6.5	.14	13	2.9	3.2	.8	32	20	3.0	.0	1.0	76	45	18	114	7.4	27	10	5.9
Dec. 1-10	1,030	8.0	.39	12	2.2	3.0	1.0	29	18	3.5	.2	.9	70	39	16	104	6.9	25	8.8	6.1
Dec. 22-31	628	6.1	.14	12	2.8	4.2	1.0	31	--	5.0	.0	1.2	--	42	16	112	6.9	15	--	--
Jan. 1-6,10,1956	538	7.6	--	11	2.7	5.0	1.1	33	18	3.0	.2	1.4	72	39	12	107	7.2	17	5.3	5.0
Jan. 7,9	537	--	--	--	--	--	--	57	--	3.4	--	1.6	--	59	12	147	7.5	--	--	--
Jan. 8	509	--	--	--	--	--	--	246	--	31	--	3.7	--	260	58	496	7.6	--	--	--
Jan. 1-10	528	--	.25	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Jan. 11-15,17-20	801	6.8	--	11	4.2	3.6	2.6	36	--	4.6	.0	2.6	--	45	15	118	6.9	20	--	--
Jan. 21-31	514	1.0	.16	11	3.2	4.5	1.3	33	17	4.2	.2	2.0	71	41	14	109	7.0	12	5.1	4.4
Feb. 1-10	518	7.6	.33	11	3.7	4.6	1.0	38	15	4.5	.1	1.2	75	43	12	111	7.0	11	6.8	4.1
Feb. 11-20	565	7.6	.28	11	3.4	4.7	1.0	39	--	4.0	.0	1.6	--	42	10	114	7.1	13	--	--
Feb. 21-29	650	7.8	.42	12	3.2	4.1	1.2	35	18	5.0	.1	1.1	78	43	15	115	6.9	12	6.2	4.3
Mar. 1-10	1,400	6.1	.29	12	4.2	3.5	3.0	38	16	5.0	.1	3.5	82	47	16	122	6.9	19	7.4	5.2
Mar. 11-20	1,820	7.0	.29	9.8	2.5	3.3	1.5	31	--	3.2	.2	2.2	--	35	10	102	7.0	12	--	--
Mar. 21-30	1,190	7.5	.38	11	2.6	2.6	1.1	30	15	3.0	.1	1.2	70	38	14	99.5	6.9	15	6.6	5.4
Apr. 1-10	7,190	7.2	.38	10	3.2	2.0	1.7	30	14	3.1	.1	3.3	68	38	14	99.8	6.6	16	8.2	5.0
Apr. 11-20	6,160	4.9	.10	8.8	4.3	1.8	.9	30	--	2.2	.1	1.8	--	40	15	86.0	7.0	22	--	--
Apr. 21-30	3,240	5.0	.25	11	4.0	2.0	.9	35	13	3.1	.1	2.2	66	44	15	95.0	7.4	27	8.9	6.4
May 1-10	5,300	4.7	.20	10	3.7	2.0	1.0	31	13	3.0	.1	1.9	66	40	15	92.9	7.3	32	8.6	7.1
May 11-20	3,160	5.9	.11	11	4.9	2.4	.8	42	--	2.0	.2	1.3	--	48	13	103	7.3	33	--	--
May 21-31	2,800	5.4	.34	11	3.6	2.5	.8	39	11	3.3	.1	1.6	69	42	10	101	7.6	34	9.4	7.4
June 1-10, 1956	3,840	4.8	.38	10	3.3	2.0	.8	34	11	2.1	.1	1.4	66	39	11	89.6	7.0	36	11	9.0
June 11-20	1,060	4.4	.55	11	3.3	2.6	.9	40	10	2.7	.2	1.7	69	42	9	97.6	7.0	34	12	7.6
June 21-30	523	6.0	.43	12	4.0	2.6	1.3	46	10	2.9	.2	1.7	77	47	9	112	7.6	35	7.7	6.7
July 1-10	533	5.7	.38	13	4.3	3.0	1.3	48	13	3.1	.2	1.5	79	51	11	118	7.6	28	7.2	6.0
July 11-20	626	7.0	.41	12	3.6	4.0	1.3	41	14	4.1	.2	1.5	76	45	12	113	7.6	28	6.5	5.8
July 21-31	478	4.4	.16	10	2.8	4.1	.9	34	12	3.1	.2	1.5	64	37	9	95.9	7.1	22	7.1	6.6
Aug. 1-10	330	5.2	.52	11	2.2	4.1	.9	33	13	3.8	.0	2.4	66	37	10	97.9	7.1	25	7.9	6.0
Aug. 11-20	393	5.6	.40	12	2.4	4.6	.9	37	15	4.1	.0	2.4	71	40	10	109	7.1	20	7.3	5.2
Aug. 21-31	348	6.2	.34	12	3.9	5.4	1.0	44	14	4.4	.2	.7	73	46	10	118	7.5	8	--	--
Sept. 1-10	560	3.9	.39	13	3.2	5.3	1.2	39	19	4.5	.2	1.1	70	46	14	118	7.1	9	5.6	4.5
Sept. 11-20	417	4.4	.56	11	3.4	4.5	1.2	39	13	4.5	.2	.9	70	42	10	112	7.1	17	8.0	6.6
Sept. 21-30	601	4.7	.48	10	3.7	4.7	1.2	37	14	4.1	.2	1.0	67	41	10	106	7.0	18	7.0	6.8
Time-weighted Avg.	1,500	5.9	0.32	12	3.5	3.6	1.2	37	16	3.7	0.1	1.5	73	44	14	111	--	21	8.1	6.0
Maximum		8.0	.56	15	5.8	6.3	3.0	246	26	31	0.7	3.7	93	260	58	496	7.6	36	14	9.0
Minimum		1.0	.10	8.8	2.2	1.8	0.8	29	10	2.0	0.0	0.6	64	35	8	86.0	6.6	8	5.1	4.0

CHEMICAL QUALITY

Because of the relative insolubility of the rocks in the area, the mineral content of water from the Oswegatchie River is low (table 11). On the basis of chemical analyses of composite water samples, the dissolved-solids content was found to range from 64 to 93 ppm and to average 73 ppm. Using the equation:

$$\text{Approximate dissolved solids(ppm)} = 24 + (0.446 \times \text{specific conductance in micromhos at } 25°\text{C})$$

developed from the relationship of dissolved solids and specific conductances, estimated daily dissolved solids may be computed (fig.4). These computations show that the dissolved solids equalled or exceeded 84 ppm only 5 percent of the time (table 12).

Table 12 - Percent of days in which dissolved-solids content tabulated was equalled or exceeded in water from the Oswegatchie River at Heuvelton, 1956 water year.

	Percent						
	5	10	25	50	75	95	99
Dissolved-solids content (ppm)	84	81	77	73	69	63	60

Estimated from frequency of specific conductance and 27 analyses relating specific conductance to dissolved solids.

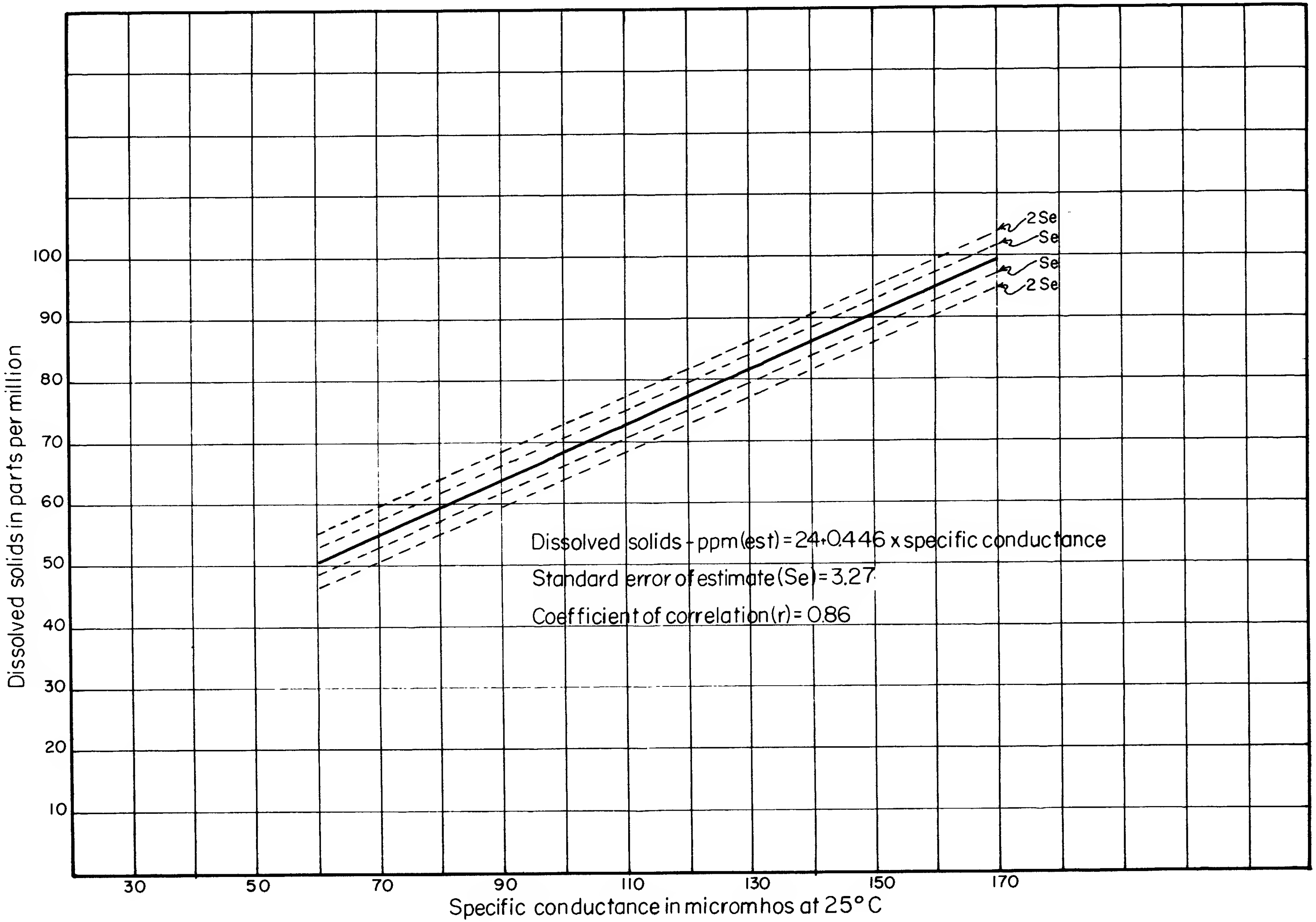

Figure 4.- Dissolved solids and specific conductances, Oswegatchie River at Heuvelton, N.Y. 1956 water year.

Generally, an increase in stream discharge will reduce the concentrations of dissolved solids. The Oswegatchie River for a time deviated from this pattern at Heuvelton (fig.5). From October 1955 to February 1956 and again from July to September 1956, little or no correlation between stream discharge and dissolved-solids content is evident. But from March to June of 1956, an inverse relation existed; as discharges of the stream increased the dissolved-solids content decreased. Heuvelton is about 100 miles downstream from Cranberry Lake, a storage reservoir on the Oswegatchie River having a total capacity of 2.53 billion cubic feet. Mixing within the reservoir probably is partially responsible for maintaining the uniform chemical quality of the water from the Oswegatchie River at Heuvelton.

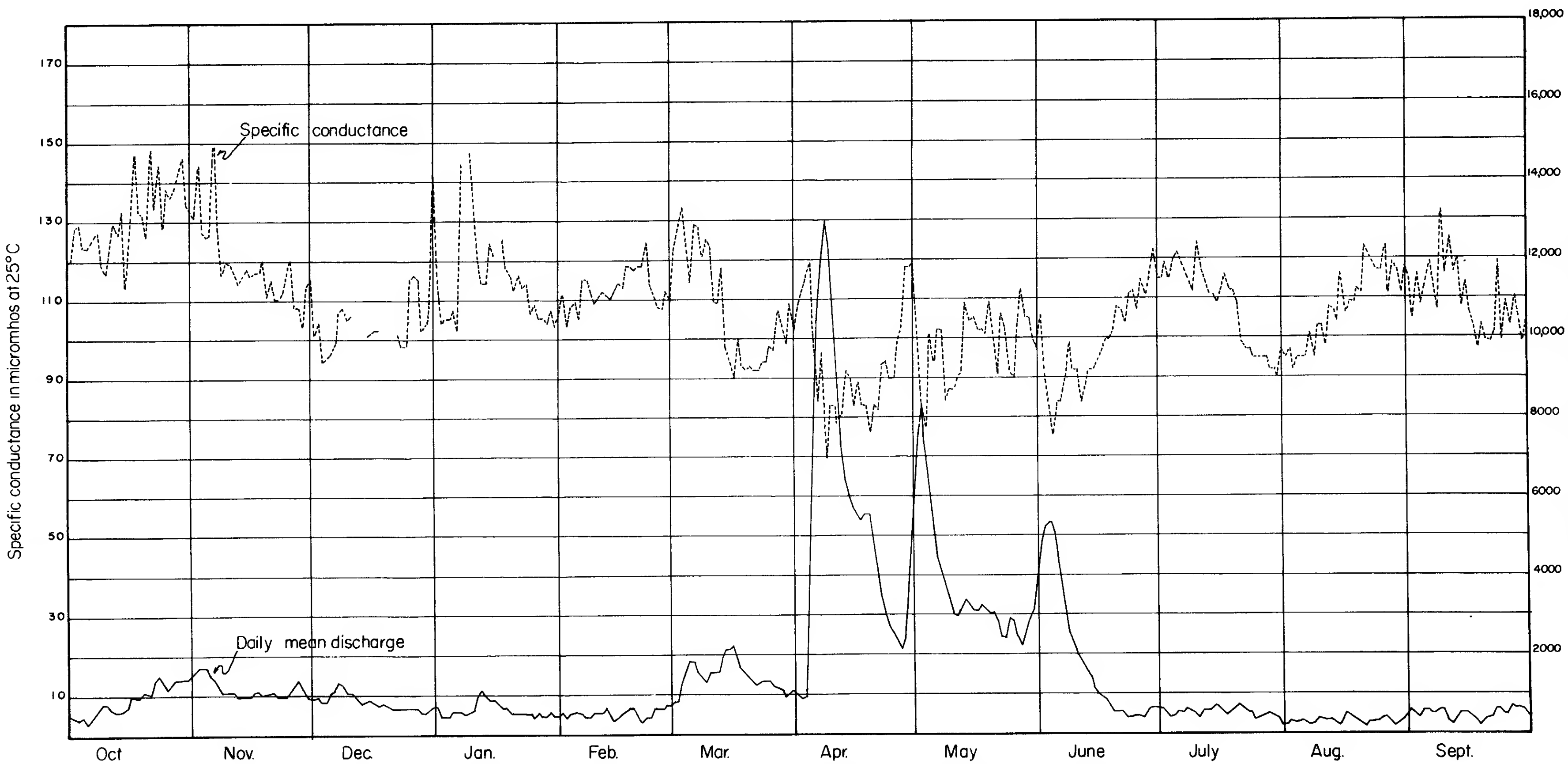

Figure 5.- Specific conductance and daily mean discharge, Oswegatchie River at Heuvelton, N.Y. 1956 water year

Concentrations of most individual mineral constituents in water from the Oswegatchie River remained low and uniform. The iron concentration however, fluctuated erratically with stream discharge (table 11). The iron concentration ranged from 0.10 to 0.56 ppm and averaged 0.32 ppm. Intermittent seepage of water from iron mines in the Oswegatchie River basin probably is the cause for the erratic fluctuations of the iron concentrations.

Deposits of calcareous sandstones and sandy dolomite are found near Heuvelton. Drainage from these rocks contributed largely to the chemical composition of the water of the Oswegatchie River at Heuvelton; principally calcium, magnesium, and bicarbonate. Although these ions constituted a large percentage of the dissolved solids, the average concentration of each ion was low (table 11). This condition may be due to the dilution effect produced by upstream discharge and inflow of Lisbon Creek and several smaller tributaries in the vicinity of the sampling site.

The water from the Oswegatchie River was relatively soft with the hardness equalling or exceeding 52 ppm only 5 percent of the time (table 13).

Table 13 - Percent of days in which tabulated values of hardness as $CaCO_3$ were equalled or exceeded in water from the Oswegatchie River at Heuvelton, 1956 water year.

	Percent						
	5	10	25	50	75	95	99
Hardness as $CaCO_3$ (ppm)	52	49	46	44	40	36	33

Estimated from frequency of specific conductance and analyses relating specific conductance to hardness as $CaCO_3$.

The sulfate concentration ranged from 10 to 26 ppm and averaged 16 ppm. Some of the sulfate in the water of the Oswegatchie River probably resulted from the oxidation of iron and zinc sulfides. These minerals are oxidized during the weathering process to give soluble sulfates, which are carried off by water.

The silica concentration ranged from 1 to 8 ppm and averaged 5.9 ppm. Probably some of the silica in the stream comes from the ferromagnesian and feldspathic minerals that are found in the area. Feldspathic minerals includes those formed by silica in union with aluminum, together with either potassium, sodium or calcium, or two or more of these together. The ferromagnesian minerals are those formed by the union of silica with iron, magnesium and calcium,

together with some of the other basic oxides. Both feldspathic and ferromagnesian minerals undergo weathering and serve as a source of silica in natural water.

Other dissolved mineral constituents, included sodium, potassium, chloride, fluoride and nitrate. The concentrations of these ions constituted only a small percentage of the dissolved-solids content. The time-weighted average concentration for chloride was 3.7 ppm and the concentrations of the other constituents was even lower.

The pH of surface water generally ranged from 7 to 8. The pH of composited samples of water from the Oswegatchie River ranged from 6.6 to 7.6.

POLLUTION

Data from the NENYIAC report shows the Oswegatchie River to be polluted by sanitary and industrial wastes at several points. However, it does not appear that these wastes affected the chemical quality significantly. The concentrations of mineral constituents in water from the river were well within the tolerance limits established for many industrial processes.

WATER TEMPERATURE

The average water temperature of the Oswegatchie River for the period of 1955-1956 was 49°F. Water temperatures remained above 49°F during most of October 1955 but dropped below 49°F during the latter part of the month. Through November 1955, the water temperature gradually dropped to near the freezing point and hovered there from December 1955 to the early part of April 1956. For the remainder of the water year, temperatures fluctuated above the average and reached a maximum of 78°F in early September (fig. 6 and table 15). Table 14 shows percent of time when water temperatures given were equalled or exceeded.

Table 14 - Percent of days in which tabulated values of water temperatures were equalled or exceeded in the Oswegatchie River at Heuvelton, 1956 water year.

	Percent						
	5	10	25	50	75	95	99
Temperature (°F)	75	74	68	49	36	34	33

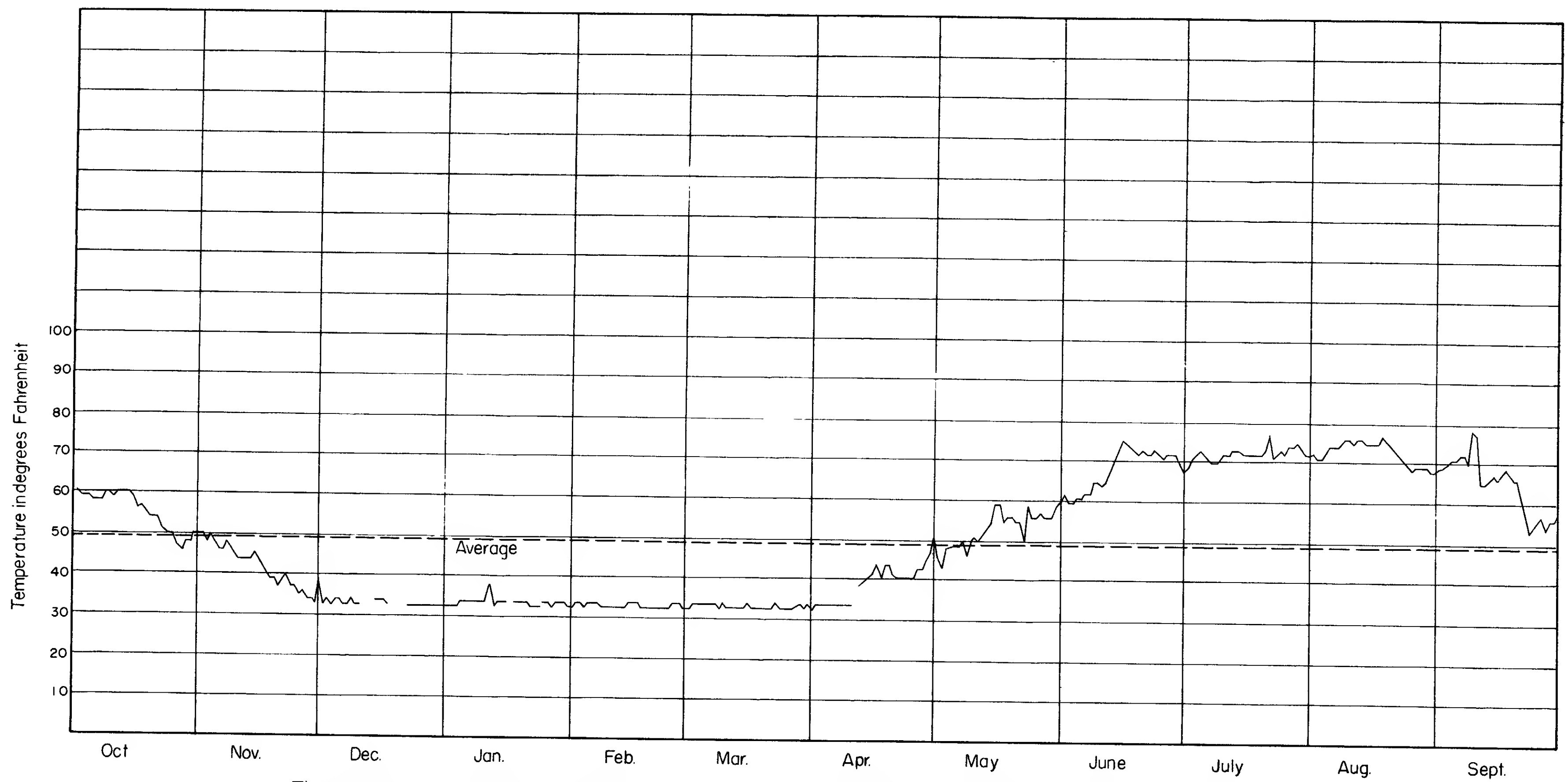

Figure 6.- Daily water temperature in degrees Fahrenheit, Oswegatchie River at Heuvelton, N.Y. 1956 water year

Table 15.—Daily water temperatures of the Oswegatchie River at Heuvelton, N.Y.

Temperature (°F) of water, 1956 water year

Day	October 1955	November	December	January 1956	February	March	April	May	June	July	August	September
1	60	50	33	33	34	33	34	46	62	69	72	69
2	59	48	34	33	34	34	34	44	60	71	71	69
3	59	50	33	33	33	34	34	48	60	72	71	70
4	59	48	34	34	34	34	34	—	61	73	73	71
5	58	46	34	34	34	34	34	49	61	72	74	71
6	58	46	33	33	34	34	34	49	62	71	74	72
7	58	48	33	34	33	34	34	50	63	70	74	72
8	60	46	34	34	33	33	34	47	65	70	75	70
9	60	45	33	34	33	34	34	50	65	71	76	78
10	59	44	33	34	33	33	34	51	64	72	76	77
11	60	44	—	38	33	33	—	50	65	72	75	65
12	60	44	—	33	33	33	39	52	68	73	76	65
13	60	44	—	34	33	33	40	—	71	73	76	66
14	60	45	34	34	34	33	41	55	73	73	75	67
15	59	44	—	34	34	34	42	59	75	72	75	66
16	56	42	33	—	34	33	44	59	75	72	75	67
17	56	41	33	34	33	33	41	55	74	72	75	69
18	55	39	—	34	33	33	44	56	73	72	77	62
19	54	39	—	34	33	33	44	56	72	72	76	61
20	54	37	—	34	33	33	42	55	73	73	75	61
21	54	39	—	33	33	33	41	55	72	77	74	60
22	51	40	33	33	33	34	41	50	72	71	72	57
23	50	37	33	33	33	33	41	59	73	72	71	53
24	50	37	33	34	33	33	41	56	72	73	70	55
25	49	35	33	34	34	33	41	56	71	72	68	56
26	47	36	33	33	34	33	43	57	72	74	69	57
27	46	34	33	34	33	34	43	56	72	74	69	54
28	48	34	33	34	33	34	45	56	72	75	69	56
29	48	33	33	34	33	33	47	56	70	74	69	56
30	50	39	33	34	—	34	51	59	68	72	68	57
31	50	—	33	33	—	33	—	60	—	72	68	—
Average	55	42	—	34	33	33	40	53	69	72	73	64

SUMMARY

The Oswegatchie River drains an area that consists of Cambrian sandstone and Precambrian crystalline rocks overlain by unconsolidated deposits of sand and gravel. Because of the low solubility of these deposits, only moderate quantities of mineral matter are dissolved. This condition is reflected in the chemical quality of the Oswegatchie River by low concentrations of dissolved solids and very low hardness. The chemical constituents of the river water consists principally of silica, calcium, magnesium, sodium, bicarbonate and sulfate and lesser quantities of other constituents. The concentration of these constituents, with the exception of iron, usually remained low and uniform. Iron concentrations fluctuated and frequently exceeded the limits recommended for some industrial uses. However, on the basis of the overall chemical quality of the water from the Oswegatchie River, during the water year of October 1, 1955 to September 30, 1956, is satisfactory for most industrial, agricultural, and public water-supply purposes.

Black River at Watertown, N. Y.

The Black River rises in North Lake near the boundary of Hamilton and Herkimer Counties and flows about 15 miles southwest until it reaches Forestport Reservoir (Plate 1). In the Forestport area, the river changes its course and flows in a northwest direction for about 73 miles to Deferiet. From Deferiet, the river flows 24 miles west to Dexter where it enters Black River Bay, an extension of Lake Ontario. Several major tributaries flow into the Black River along its course. The Black River drains an area of 1,876 square miles at the stream-gaging station at Watertown.

The sampling site on the Black River was located at a dam at the Watertown Municipal power plant about 1.6 miles upstream from U. S. Geological Survey stream-gaging station.

From Deferiet to the mouth of Little Black Creek, the Black River follows the contact between the Precambrian metamorphic rocks of the Central Adirondacks and the Trenton limestone of the Middle Ordovician age. In general, that portion of the basin draining the southwestern slope

of the Adirondack Plateau is underlain by Precambrian rocks. To the west, the basin is underlain by Trenton limestone and by shales and schists of Ordovician age.

Table 16.-Analyses of water from the Black River at Watertown, N.Y.

LOCATION.--At dam at Watertown Municipal Power Plant, Watertown, Jefferson County, and about 1.6 miles upstream from gaging station.
DRAINAGE AREA.--1,876 square miles.
RECORDS AVAILABLE.--Chemical analyses: October 1955 to September 1956.
Water temperatures: October 1955 to September 1956.
EXTREMES, 1955-56.--Dissolved solids: Maximum, 94 ppm Mar. 1-10; minimum, 48 ppm May 1-10.
Hardness: Maximum, 59 ppm Mar. 1-10; minimum, 18 ppm Dec. 22.
Specific conductance: Maximum, 137 micromhos Mar. 1-10; minimum, 51.6 micromhos Dec. 22.
Water temperatures: Maximum, 75°F on several days during June and August, minimum, 34°F on several days during November, December and January.
REMARKS.--Records of pH and specific conductance of daily samples available in district office at Albany, N.Y. Record of discharge for water year October 1955 to September 1956 given in Water-Supply Paper 1437.
No appreciable inflow between sampling location and gaging station.

(Chemical constituents, dissolved solids, and hardness in parts per million, 1956 water year)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color	Oxygen consumed	
														Calcium magnesium	Noncarbonate				Unfiltered	Filtered
Oct. 1-10, 1955	2,080	5.7	0.38	10	1.6	3.0	1.0	26	15	2.4	0.0	0.2	66	32	10	82.5	6.5	25	17	10
Oct. 11-20	3,280	7.0	.36	13	1.7	2.8	1.3	24	--	2.0	.1	.7	--	40	20	93.0	6.5	30	--	--
Oct. 21-30	3,150	7.8	.36	13	1.8	2.7	1.1	30	17	2.8	.0	1.0	74	40	16	95.7	7.0	35	16	10
Nov. 1-10	3,890	6.9	.36	12	1.7	2.4	1.0	30	14	2.3	.0	.2	68	37	13	89.5	7.0	35	17	7.8
Nov. 11-20	3,720	5.9	.36	12	.9	2.4	.9	32	--	2.8	.0	.7	--	34	8	94.3	6.9	29	--	--
Nov. 21-30	3,580	7.3	.34	13	1.0	2.1	.7	28	15	1.9	.1	.7	69	37	14	89.2	6.8	30	13	9.6
Dec. 1-10	3,430	8.0	.27	14	1.3	2.8	.8	35	15	2.5	.2	.7	78	40	12	106	6.9	30	12	9.5
Dec. 11,16,17,19	2,270	6.4	.25	12	1.5	2.8	.9	30	--	2.5	.0	1.2	--	36	12	94.9	7.0	24	--	--
Dec. 22	1,900	--	--	--	--	--	--	12	--	--	--	2.4	--	18	8	51.6	6.2	--	--	--
Dec. 21,24-31	1,910	5.6	.21	14	2.0	2.5	.8	35	--	4.4	.1	1.0	--	44	15	107	6.7	22	--	--
Jan. 1-10, 1956	1,500	8.0	.22	13	2.6	3.0	.8	35	17	3.2	.1	.2	79	43	15	107	6.7	17	19	9.8
Jan. 11-20	1,680	8.0	.30	13	2.1	3.0	.7	37	--	3.0	.0	1.1	--	41	11	105	6.9	18	--	--
Jan. 21-31	1,250	9.0	.23	13	2.4	3.4	.8	32	19	3.6	.1	.2	84	43	16	107	6.7	20	19	11
Feb. 1-10	1,360	8.2	.40	14	1.9	3.6	.6	32	21	2.9	.2	.7	83	43	17	107	6.9	20	16	10
Feb. 11-20	1,370	8.3	.30	14	2.4	3.3	.8	35	--	2.5	.2	.6	--	45	16	106	6.9	20	--	--
Feb. 21-29	1,450	8.0	.26	14	2.7	3.3	.7	38	18	3.5	.2	.3	86	46	15	119	6.8	23	19	10
Mar. 1-10	2,690	7.2	.15	18	3.3	2.9	.9	50	18	4.4	.2	.5	94	59	18	137	6.8	23	14	9.9
Mar. 11-20	3,720	7.0	.21	16	2.9	2.5	1.0	47	--	2.5	.2	.9	--	52	14	120	7.0	20	--	--
Mar. 21-31	2,220	7.5	.16	16	2.7	2.9	.8	43	18	3.6	.2	.3	90	51	16	121	6.8	27	14	10
Apr. 1-5	4,550	7.0	--	17	3.5	2.8	1.0	48	17	4.5	.1	2.2	91	57	18	134	6.8	18	20	8.4
Apr. 6-10	16,000	5.2	--	12	1.2	1.3	1.0	31	9.7	.6	.0	3.5	55	35	10	83.4	6.8	18	6.7	4.3
Apr. 1-10	--	--	.39	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Apr. 11-20	13,700	4.9	.06	11	2.4	1.7	.6	31	--	2.2	.2	2.4	--	37	12	85.6	7.2	--	--	--
Apr. 21-30	7,820	5.2	.20	10	2.1	1.7	.7	27	9.8	2.3	.2	2.0	56	34	12	78.4	7.5	12	9.4	7.0
May 1-10	11,200	4.3	.21	8.0	2.0	1.2	.6	22	9.1	1.9	.1	2.2	48	28	10	65.9	7.3	15	11	7.4
May 11-20	6,380	4.3	.11	10	2.0	2.2	.6	31	--	1.2	.2	.7	--	33	8	76.9	7.0	23	--	--
May 21-31	4,320	4.9	.41	12	2.0	1.7	.6	34	10	2.1	.1	1.7	66	38	11	88.9	7.4	27	13	9.2
June 1-10	8,030	4.5	.68	12	1.6	1.4	.7	32	10	2.5	.1	1.4	62	37	11	82.0	6.9	32	14	9.0
June 11-20	2,400	7.0	.65	13	2.3	2.5	.8	37	12	4.0	.2	.9	72	42	12	96.8	6.8	27	15	10
June 21-30	1,480	5.2	.67	14	1.9	2.3	.8	36	14	4.0	.2	.8	79	43	14	104	6.6	23	16	11
July 1-10	1,430	6.0	.60	14	1.7	2.5	.7	38	11	3.1	.2	.7	75	42	11	98.4	6.7	24	16	11
July 11-20	3,050	6.0	.25	11	1.6	2.4	.7	31	9.3	2.2	.2	.8	66	34	9	81.6	7.0	38	16	10
July 21-31	1,520	5.2	.27	11	1.2	2.4	.6	27	12	2.2	.2	.8	68	33	11	80.5	6.9	35	17	11
Aug. 1-10	1,260	6.2	.66	13	1.3	3.2	.7	30	17	2.9	.0	1.4	89	38	14	96.3	6.5	35	27	25
Aug. 11-20	1,190	5.9	.51	12	2.6	2.8	.8	31	15	4.2	.2	.8	81	41	16	92.9	7.3	20	--	--
Aug. 21-31	1,240	6.3	.59	13	2.3	3.0	.8	35	15	4.2	.2	.6	84	42	14	99.3	6.8	25	--	--
Sept. 1-10	3,050	6.2	.45	9.9	1.7	2.1	.8	26	11	2.0	.1	.5	59	32	11	73.4	6.8	25	16	9.2
Sept. 11-20	1,830	6.1	.52	10	2.3	2.3	.7	25	13	2.9	.1	1.4	69	35	14	80.3	6.8	38	18	16
Sept. 21-30	3,500	6.7	.51	9.5	1.9	2.1	.6	25	11	2.4	.1	.6	62	32	11	73.0	6.8	30	17	14
Time-weighted avg.	3,570	6.5	0.36	13	2.0	2.5	0.8	33	14	2.8	0.1	0.9	73	40	13	95.5	--	26	16	11
Maximum		9.0	0.68	18	3.5	3.6	1.3	50	21	4.5	0.2	3.5	94	59	20	137	7.5	38	27	25
Minimum		4.3	0.06	8.0	0.9	1.2	0.6	12	9.1	0.6	0.0	0.2	48	18	8	52	6.2	12	6.7	4.3

CHEMICAL QUALITY

An appraisal of the chemical quality data indicates that the geologic formations of the area contribute only a moderate amount of mineral matter to the river. The range of dissolved solids was from 48 to 94 ppm with a time-weighted average of 73 ppm (table 16). Concentrations of dissolved solids from the Black River equalled or exceeded 92 ppm only 5 percent of the time (table 17). These low concentrations of dissolved solids are an indication of good chemical quality.

Table 17 - Percent of days in which dissolved-solids content tabulated was equalled or exceeded in water from the Black River at Watertown, 1956 water year.

	Percent						
	5	10	25	50	75	95	99
Dissolved-solids content (ppm)	92	87	80	73	65	57	52

Estimated from frequency of specific conductance and 28 composite water analyses relating specific conductance to dissolved solids.

Figure 7 shows that for a large part of the water year there was an inverse relationship between concentrations of dissolved solids (computed from specific conductances) and daily-mean discharges. As the discharge of the Black River

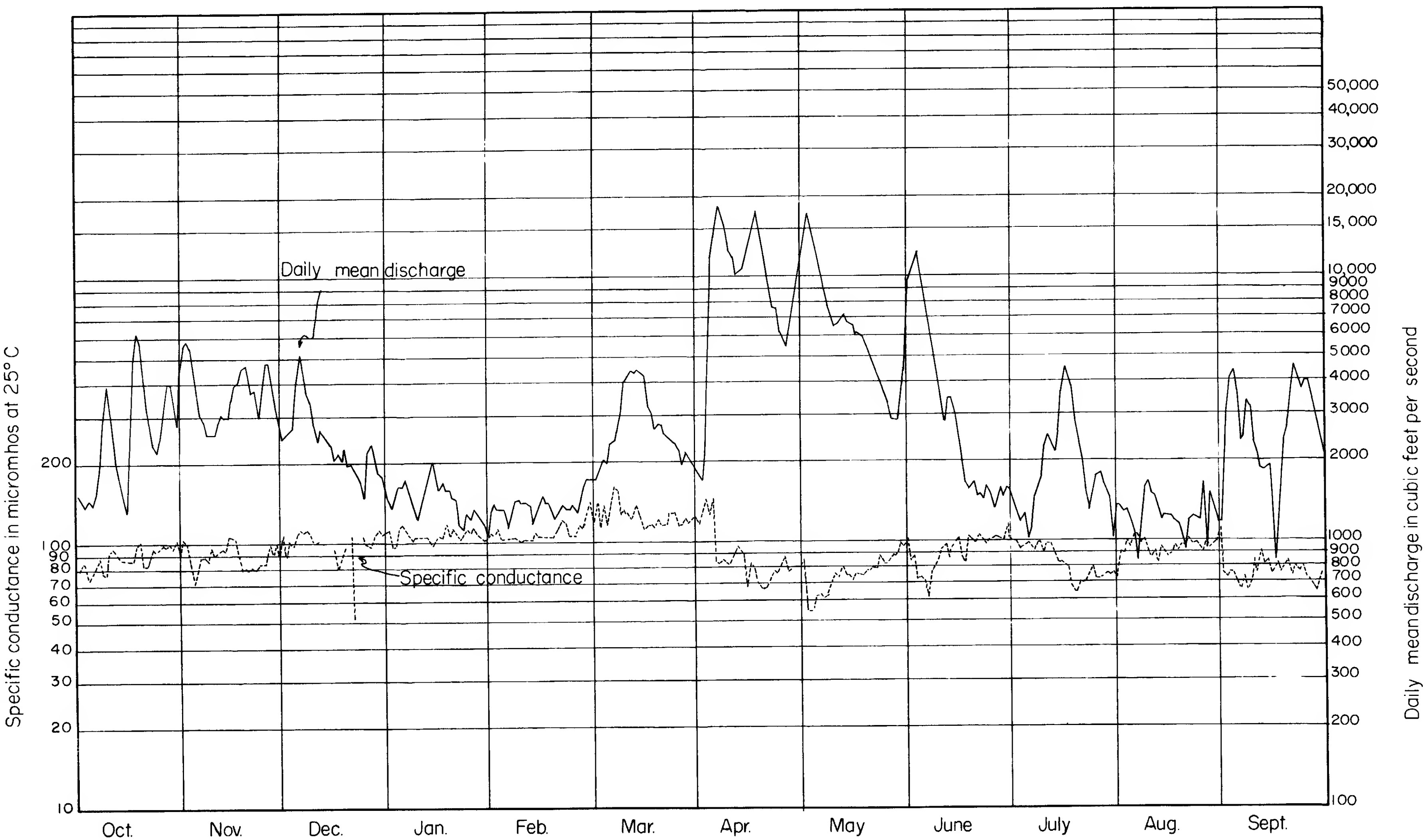

Figure 7.- Specific conductance and daily mean discharge, Black River at Watertown, N.Y. 1956 water year

increased, concentrations of dissolved solids decreased. However, during the period of January to March 1956, little or no correlation existed between stream discharge and concentrations of dissolved solids on several occasions.

Throughout the period, with the exception of iron, the concentrations of dissolved solids did not deviate extensively from the time-weighted averages.

It is interesting to note that, although the Black River flows through limestone areas, the concentrations of calcium only ranged from 8 to 18 ppm, and the time-weighted average of calcium was 13 ppm. Moreover, magnesium ion concentration ranged from 0.9 to 3.5 ppm, and the time-weighted average of magnesium was 2.0 ppm.

It is possible that calcium and magnesium ion concentrations were kept continously low by the high overland runoff from the crystalline rock of the Adirondack areas and by inflow from streams from these areas.

Hardness of water from the Black River was very low. The hardness of water from the river equalled or exceeded 52 ppm only 5 percent of the time (table 18).

Table 18 - Percent of days in which tabulated values of hardness as $CaCO_3$ were equalled or exceeded in water from the Black River at Watertown, 1956 water year.

	Percent						
	5	10	25	50	75	95	99
Hardness as $CaCO_3$ (ppm)	52	49	44	40	35	29	25

Estimated from frequency of specific conductance and 28 composite analyses relating specific conductance to hardness as $CaCO_3$.

Bicarbonate and sulfate ion concentrations ranged from 12 to 50 ppm and 9.1 to 21 ppm respectively; the time-weighted average of each ion was 33 and 14 ppm, respectively.

The average concentration of other constituents - sodium, potassium, chloride, fluoride and nitrate was less than 2.9 ppm (table 16).

The pH of water generally ranged from 6.2 to 7.5. However, several times the pH was as low as 6.1 and, also, as high as 8.0. The specific cause for these departures from the usual range is not known, but pollution is suspected.

POLLUTION

According to the report entitled, "The Black River Drainage Basin," by the Water Pollution Control Board of the New York State Department of Health, the sanitary quality along various points of the Black River was affected by industrial and municipal pollution. Nevertheless, the city of Watertown and several villages in the upper Black River basin use water from the river for domestic and industrial purposes. Treatment of the water from the Black River before distribution includes prechlorination, coagulation, sedimentation, filtration, aeration, and postchlorination.

The effect of the pollution on the chemical quality of the Black River is unknown.

WATER TEMPERATURE

The maximum water temperature of the Black River at Watertown for the water year of 1955-56 was 75°F. The minimum water temperature for this period at the same location was 34°F (fig.8). Table 19 shows the

Table 19 - Percent of days in which tabulated values of water temperatures were equalled or exceeded in the Black River at Watertown, 1956 water year.

	Percent						
	5	10	25	50	75	95	99
Temperature (°F)	75	74	68	50	38	36	35

percent of time water temperature given was equalled or exceeded. Additional water temperatures are given in table 20.

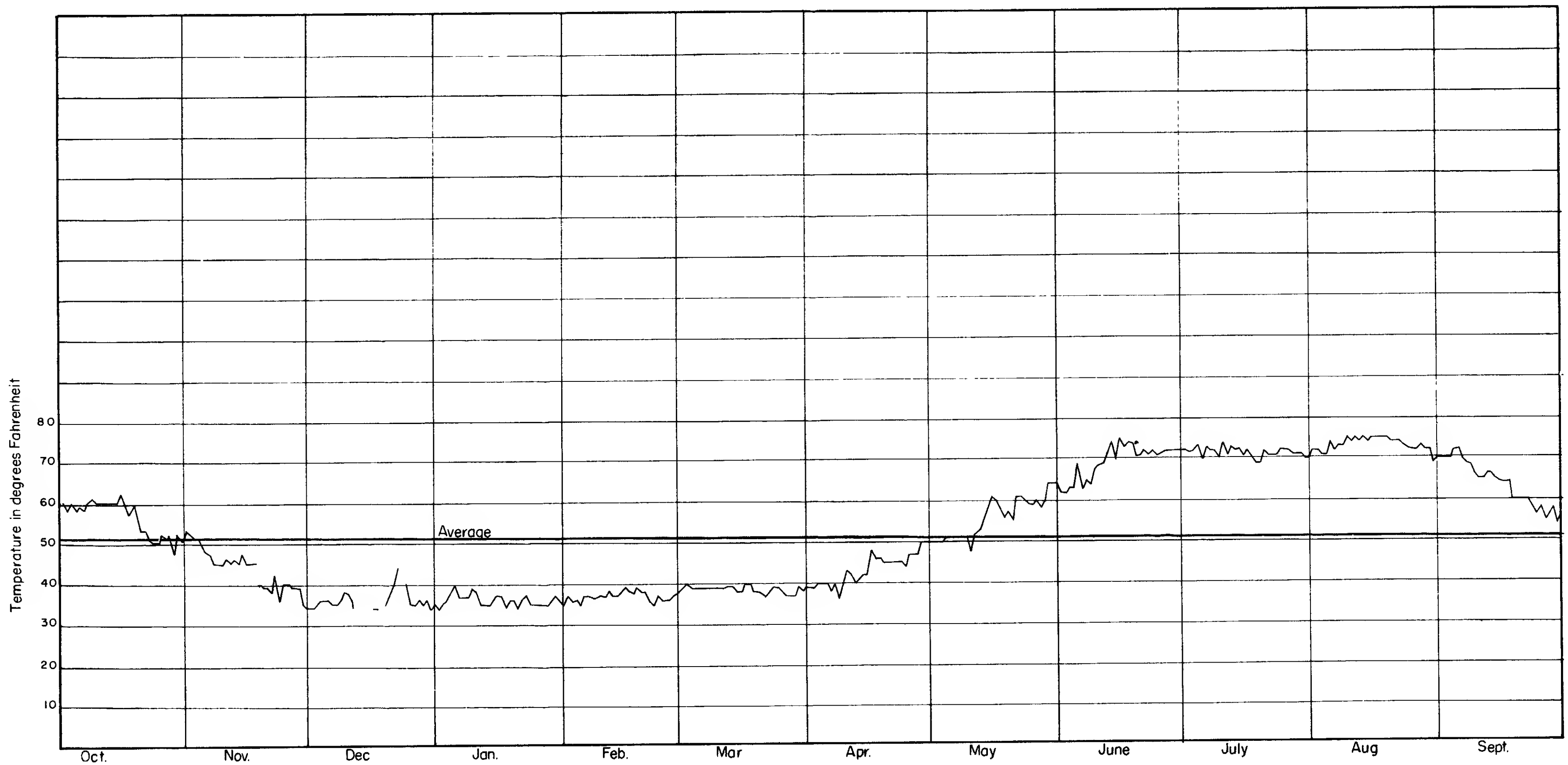

Figure 8.- Daily water temperature in degrees Fahrenheit, Black River at Watertown, N.Y.
1956 water year

Table 20.-Daily water temperatures of the Black River at Watertown, N. Y.

Temperature (°F) of water, 1956 water year

Day	October 1955	November	December	January 1956	February	March	April	May	June	July	August	September
1	60	52	34	34	37	39	39	50	62	72	72	70
2	58	51	35	35	36	40	39	50	62	72	72	70
3	60	51	36	36	36	39	40	50	63	72	71	70
4	58	49	36	38	35	39	40	51	63	73	71	72
5	59	48	36	40	37	39	40	51	69	70	74	72
6	58	47	35	37	37	39	38	51	63	73	72	70
7	60	45	35	37	37	39	40	51	65	72	73	69
8	61	45	36	37	37	39	36	51	64	72	73	68
9	60	45	38	39	37	39	40	51	68	70	75	66
10	60	46	37	38	37	39	43	48	69	74	74	65
11	60	45	34	35	38	39	42	52	69	71	75	65
12	60	46	—	35	37	39	40	53	71	73	74	66
13	60	45	—	35	37	39	41	55	74	72	75	66
14	60	47	—	36	38	38	42	57	70	72	74	65
15	62	45	—	37	39	38	42	61	75	71	75	64
16	60	45	34	37	38	40	48	60	73	72	75	64
17	57	45	34	34	38	40	46	58	74	70	75	64
18	59	40	—	36	39	38	46	56	74	69	75	60
19	57	39	35	36	38	38	45	57	71	69	75	60
20	53	39	—	34	38	38	45	55	71	72	74	60
21	53	38	40	36	36	37	45	61	72	71	74	60
22	51	42	44	37	35	38	45	61	71	71	74	60
23	50	36	—	35	37	39	45	60	72	71	73	58
24	50	40	40	35	36	—	44	59	71	72	72	56
25	52	40	35	35	36	38	47	59	71	72	72	58
26	51	39	35	35	36	38	47	60	72	72	72	55
27	52	39	36	35	37	38	47	58	72	71	73	56
28	47	39	35	36	38	38	50	60	72	71	72	58
29	52	35	36	37	38	39	—	64	72	71	72	54
30	50	34	34	36	—	38	50	64	72	70	69	56
31	53	—	35	35	—	39	—	64	—	70	70	—
Average	56	43	—	36	37	39	43	56	70	71	73	63

SUMMARY

On the basis of dissolved solids, the chemical quality of water from the Black River during the 1956 water year is generally satisfactory for industrial, agricultural, and public water-supply purposes. Although this report contains little chemical quality data on the tributaries of the Black River, the data available indicate that the chemical quality is good. The dissolved solids and hardness of water values of these streams were moderately low. The chemical quality of the river at Watertown and upstream from this point are about the same.

Grass River at Pyrites, N. Y.

The Grass River is formed by the confluence of the South and Middle Branches, about 2 miles north of Degrasse in St. Lawrence County. The South Branch rises on the slopes of Long Tom Mountain in the southeastern part of the county, at an altitude of about 1,500 feet, and is the outlet for Lake Massawepie. It then flows northwest through Grass River Flow, a low-lying piece of watery-land, to join the Middle Branch. The Middle Branch rises on the slopes of Buckhorn Ridge, approximately 9 miles northwest of Cranberry Lake. The North Branch, flowing from the east, joins the stream about 4 miles northwest of the junction of the South and Middle Branches. Grass River then flows generally north from Canton to Chase Mills. At Chase Mills, the river veers east through Massena, and finally empties into the St. Lawrence River at a point opposite Cornwall, Ontario. The principal tributaries of the Grass River are Little River and Harrison Creek (Plate 1). At the stream-gaging station at Pyrites, the Grass River has a drainage area of 335 square miles.

The three branches of the Grass River, including much

of the main stream itself, flow through areas that contain large masses of Precambrian crystalline rocks. A few miles north of Canton, the Grass River leaves these areas and flows through a narrow corridor of Cambrian sandstones. From Madrid and to the point where the Grass River enters the St. Lawrence River, the rocks consist of Ordovician limestones (Plate 2).

Table 21.-Analyses of water from the Grass River at Pyrites, N.Y.

LOCATION.--At bridge, 1,000 ft. upstream from gaging station in Pyrites, St. Lawrence County, and half a mile upstream from Harrison Creek.
DRAINAGE AREA.--335 square miles.
RECORDS AVAILABLE.--Chemical analyses: October 1955 to September 1956.
Water temperatures: October 1955 to September 1956.
EXTREMES, 1955-56.--Dissolved solids: Maximum, 67 ppm Oct. 11-20
Hardness: Maximum, 61 ppm Mar. 5; minimum 17 ppm April 11-20.
Specific conductance: Maximum, 156 micromhos Mar. 5; minimum, 47.2 micromhos April 21-30.
Water temperatures: Maximum, 78°F Aug. 8, minimum, freezing point Dec. 11, 20, 23 and Mar. 31.
REMARKS.--Records of specific conductance and pH of daily samples available in district office in Albany, N.Y. Records for discharge for water year October 1955 to September 1956 given in Water-Supply Paper 1437.

(Chemical constituents, dissolved solids, and hardness in parts per million, 1956 water year)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Non-carbonate	Specific conductance (micromhos at 25°C)	pH	Color	Oxygen consumed: Unfiltered	Oxygen consumed: Filtered
Oct. 1-10, 1955	278	9.7	0.32	6.2	3.7	1.9	0.9	27	9.1	1.5	0.0	0.8	57	31	9	70.2	6.6	32	7.9	7.4
Oct. 11-20	230	10	.32	6.7	2.7	1.8	1.0	22	13	1.9	.0	.7	67	28	10	76.9	6.7	45	11	8.7
Oct. 21-31	424	8.7	.30	7.3	2.7	1.5	1.0	20	13	1.6	.0	.8	63	30	13	71.9	6.5	45	11	8.9
Nov. 1-10	366	8.4	.34	7.0	2.8	1.8	.9	18	13	1.7	.0	.8	60	29	14	69.4	6.3	42	10	8.9
Nov. 11-20	300	9.3	.34	6.2	2.2	1.7	.8	20	11	1.2	.0	1.0	57	25	8	66.6	6.3	37	10	7.6
Nov. 21-30	357	9.4	.33	6.0	2.3	1.6	.8	19	11	1.2	.0	1.2	55	25	9	64.1	6.8	37	8.7	7.7
Dec. 1-10	302	10	.28	5.8	2.1	1.6	.8	18	11	1.2	.0	1.2	57	24	9	65.4	6.3	35	8.0	6.6
Dec. 11-20	241	10	.26	6.8	2.6	1.8	.8	21	--	1.5	.0	2.2	--	28	11	69.2	7.1	30	--	--
Dec. 21-31	194	12	.26	7.4	2.5	2.0	.8	24	10	1.9	.0	1.0	56	29	10	73.2	7.0	27	12	4.7
Jan. 1-10, 1956	178	12	.32	7.2	2.4	1.8	.8	24	9.2	1.3	.0	.8	52	28	9	69.5	7.0	18	7.8	4.5
Jan. 11-20	206	11	.26	7.4	2.2	2.0	.9	25	--	2.0	.0	2.6	--	28	7	74.6	7.2	25	--	--
Jan. 21-31	164	14	.30	8.0	3.0	2.2	.8	31	9.1	1.0	.2	2.1	59	33	7	76.8	7.3	16	5.0	4.0
Feb. 1-10	146	12	.30	7.8	3.0	2.2	.7	31	8.8	1.4	.2	2.2	57	32	7	78.3	7.5	16	4.2	3.6
Feb. 11-20	170	12	.23	7.7	3.1	2.1	.7	29	--	1.4	.0	3.4	--	32	9	73.7	7.3	10	--	--
Feb. 21-29	256	13	.10	8.0	3.3	2.9	.9	32	9.8	2.0	.2	2.6	60	34	8	82.8	7.4	23	3.9	3.7
Mar. 1-4, 6-10	408	10	--	7.9	2.7	1.6	.9	24	11	2.5	.1	2.8	54	31	11	79.5	6.8	18	5.3	4.1
Mar. 5	430	--	--	--	--	--	--	89 1/	--	.3	--	--	--	61	0	156	9.2	--	--	--
Mar. 1-10	--	--	.21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mar. 11-20	412	8.7	.12	7.6	3.2	1.5	.6	20	--	1.2	.2	2.8	--	32	16	66.6	6.8	23	--	--
Mar. 21-31	306	9.5	.25	7.6	2.7	1.7	.7	25	10	2.5	.1	1.8	54	30	10	73.0	6.5	22	5.7	4.6
Apr. 1-3,5-10	2,050	6.3	--	5.6	2.3	1.2	.9	15	9.1	2.5	.0	3.0	43	24	11	56.9	6.5	22	8.9	4.8
Apr. 4	1,200	--	--	--	--	--	--	26	--	4.0	--	2.3	--	36	15	89.6	6.4	--	--	--
Apr. 1-10	--	--	.18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Apr. 11-20	2,600	5.4	.04	4.0	1.8	1.2	.6	12	--	1.2	.2	2.9	--	17	8	48.9	6.6	28	--	--
Apr. 21-30	1,790	5.6	.14	5.2	1.6	1.2	.6	12	9.2	1.5	.1	2.3	42	20	10	47.2	6.4	28	7.3	6.1
May 1-10	2,040	5.2	.12	4.7	2.0	1.2	.6	11	9.1	1.5	.2	2.6	42	20	11	50.2	7.3	32	9.7	7.6
May 11-20	1,210	4.9	.24	5.2	2.2	1.2	.6	15	--	1.0	.1	1.5	--	22	10	53.9	7.1	35	--	--
May 21-31	1,310	4.4	.19	5.1	2.0	1.4	.5	15	8.0	1.5	.1	1.1	43	21	9	51.1	7.1	42	11	8.8
June 1-10	1,100	4.0	.38	5.6	2.2	1.1	.5	17	8.6	1.8	.2	1.4	47	23	10	52.9	6.7	55	13	9.2
June 11-20	358	6.4	.50	6.2	2.3	1.8	.6	24	--	1.0	.1	1.5	--	25	6	61.8	7.2	50	--	--
June 21-30	281	7.5	.48	7.2	2.3	1.8	.6	27	5.8	2.1	.2	1.3	53	28	6	68.2	6.8	36	8.5	7.3
July 1-10	237	7.7	.48	6.9	2.9	1.7	.7	27	6.7	1.7	.2	1.1	50	30	7	65.3	7.0	33	9.7	7.3
July 11-20	306	8.3	.56	6.1	1.8	1.7	.6	22	5.3	1.2	.2	1.2	52	23	5	56.9	6.9	55	13	12
July 21-31	153	7.5	.25	6.9	2.2	1.8	.6	26	6.0	1.6	.2	1.0	53	27	5	64.4	7.1	45	9.5	8.1
Aug. 1-10	116	8.6	.68	8.0	2.6	1.8	.7	30	6.4	2.8	.0	2.0	55	31	6	72.9	7.0	35	7.5	6.8
Aug. 11-20	126	8.2	.59	7.7	3.2	1.9	.8	31	7.4	1.8	.2	1.0	52	33	8	69.2	7.2	33	6.7	6.5
Aug. 21-31	126	8.4	.59	8.0	3.0	1.9	.8	32	6.8	1.6	.2	.8	52	33	7	73.1	7.2	33	12	6.1
Sept. 1-10	258	8.5	.42	8.0	2.3	1.7	.8	27	8.8	1.5	.0	.8	58	30	8	70.4	6.7	43	12	9.0
Sept. 11-20	158	9.7	.52	8.1	2.3	1.8	.8	29	7.4	1.3	.0	.8	55	30	6	68.2	7.0	38	10	8.6
Sept. 21-30	227	9.0	.51	7.4	2.0	1.8	.7	24	7.7	1.4	.0	.8	55	27	7	62.4	6.9	50	15	9.2
Time-weighted average	534	8.8	0.33	6.8	2.5	1.7	0.7	23	9.0	1.6	0.1	1.6	54	28	9	66.5	--	33	9.2	7.0
Maximum		14	0.68	8.1	3.7	2.9	1.0	89 1/	13	4.0	0.2	3.4	67	61	16	156	9.2	55	15	12
Minimum		4.0	0.04	4.0	1.6	1.1	0.5	11	5.3	0.3	0.0	0.7	42	17	0	47.2	6.1	10	3.9	3.6

1/ Includes equivalent of 34 parts per million of carbonate (CO_3).

CHEMICAL QUALITY

The range of dissolved solids of the Grass River at Pyrites was from 42 to 67 ppm with a time-weighted average of 54 ppm (table 21). The river had an estimated concentration of dissolved solids which equalled or exceeded 63 ppm only 5 percent of the time (table 22) at Pyrites.

Table 22 - Percent of days in which dissolved-solids content tabulated was equalled or exceeded in water from the Grass River at Pyrites, 1956 water year.

	Percent						
	5	10	25	50	75	95	99
Dissolved-solids content (ppm)	63	61	57	54	48	40	36

Estimated from frequency of specific conductance and 30 analyses relating specific conductance to dissolved solids.

Figure 9 shows the fluctuation in water quality (using specific conductance as an index) of the Grass River at Pyrites with time and discharge.

Chemical composition of water from the Grass River at Pyrites remained fairly constant during the water year; principally calcium and magnesium ion concentrations comprised approximately 21 percent of the dissolved solids

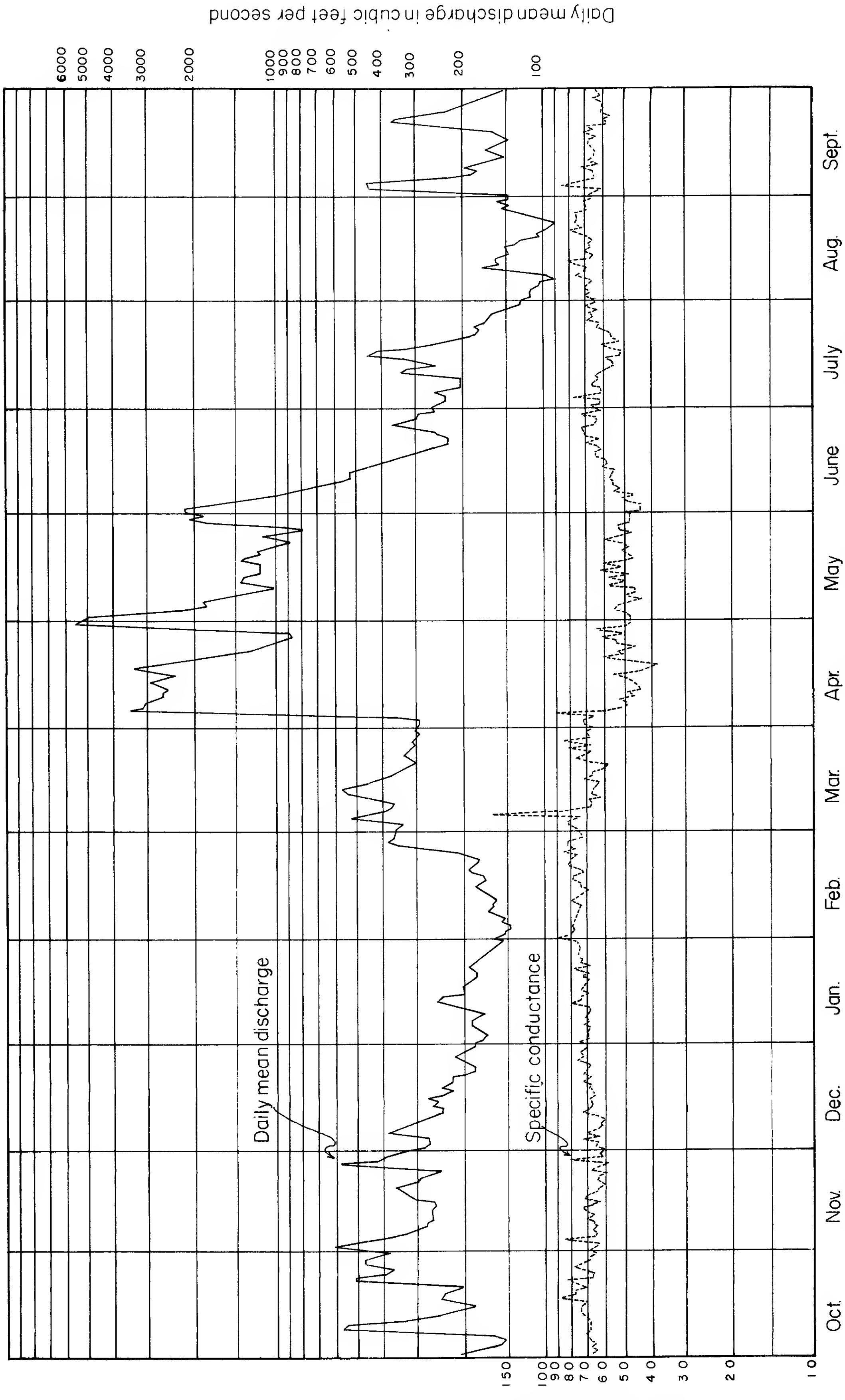

Figure 9.- Specific conductance and daily mean discharge, Grass River at Pyrites, N.Y. 1956 water year

(time-weighted average adjusted by converting bicarbonate to its carbonate equivalent). The concentrations of calcium ions ranged from 4.0 to 8.1 ppm and those of magnesium ranged from 1.6 to 3.7 ppm. The time-weighted average concentration of calcium was 6.8 ppm and that of magnesium was 2.5 ppm.

Hardness of water from the Grass River ranged from 17 to 61 ppm. Hardness of water equalled or exceeded 36 ppm only 5 percent of the time (table 23).

Table 23 - Percent of days in which tabulated values of hardness as $CaCO_3$ were equalled or exceeded in water from the Grass River at Pyrites, 1956 water year.

	Percent						
	5	10	25	50	75	95	99
Hardness as $CaCO_3$ (ppm)	36	34	31	26	22	17	13

Estimated from frequency of specific conductance and 36 composite analyses relating specific conductance to hardness as $CaCO_3$.

Probably most of the iron that is in solution in water from the Grass River is dissolved from iron-mineral deposits in the vicinities of Hermon and Pyrites. Iron concentrations ranged from 0.04 to 0.68 ppm with a time-weighted average of 0.33 ppm (table 21). They were highest during the low-

flow period when ground water drained from the iron bearing rocks was the principal component of streamflow.

Sodium, potassium, sulfate, chloride, fluoride and nitrate concentrations were low and uniform. The time-weighted average concentration of each of these irons was less than 10 ppm.

The pH of the water from the river at Pyrites generally ranged between 6.4 and 7.5. However, several times it dropped below 6.4 to a low of 6.1, and it reached a maximum pH of 9.2. The pH of 9.2 is attributed to the presence of 34 ppm of carbonate (table 21). However, carbonate was determined only once; it is not believed to be a normal constituent in water from the Grass River.

POLLUTION

Data from the NENYIAC report, shows that the sanitary quality of water from the Grass River is satisfactory for most uses. Data from the same report, show that only two sources of pollution were found throughout the 97 mile course of the Grass River. These sources are located downstream from Pyrites, at Canton and Massena. The pollution at Canton consisted of municipal wastes and that at Massena consisted of both municipal and industrial wastes.

WATER TEMPERATURE

The water temperature of the Grass River at Pyrites dropped from the upper forty-degree range in late October 1955 to the freezing point in early December. From December 1955 through March 1956, it hovered near the freezing point. The temperature began to rise in April and continued to rise, with some fluctuations, throughout the summer until it reached a maximum of 78°F in early August. Figure 10 and table 24 show that water temperatures, with one exception, were below 65°F for 8 months of the year.

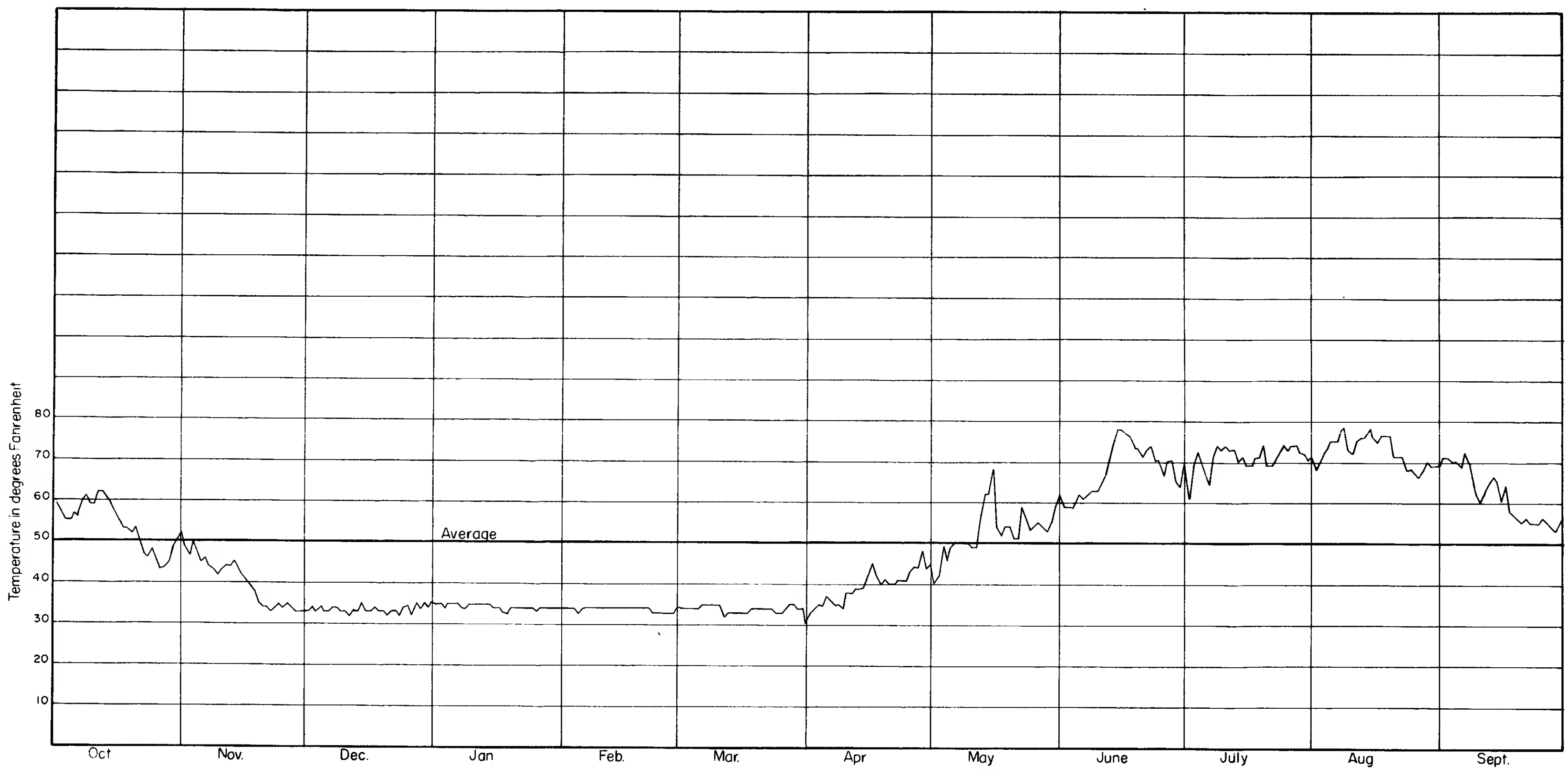

Figure 10.- Daily water temperature in degrees Fahrenheit, Grass River at Pyrites, N.Y.
1956 water year

Table 24.–Daily water temperatures of the Grass River at Pyrites, N.Y.

Temperature (°F) of water, 1956 water year

Day	October 1955	November	December	January 1956	February	March	April	May	June	July	August	September
1	59	49	33	35	34	34	33	40	59	61	68	71
2	57	47	34	35	34	34	34	42	59	69	70	71
3	55	50	33	34	34	34	35	49	59	72	72	70
4	55	48	34	35	33	34	35	46	60	70	73	70
5	57	45	33	35	34	34	37	49	62	68	75	69
6	56	46	33	35	34	35	36	50	61	65	75	72
7	60	44	34	34	34	35	35	50	62	71	—	70
8	61	43	34	34	34	35	35	50	63	74	78	65
9	59	42	33	35	34	35	34	50	63	73	73	62
10	59	43	33	35	34	35	38	49	65	74	72	60
11	62	44	32	35	34	32	38	49	67	73	75	63
12	62	44	33	35	34	33	39	57	71	73	76	65
13	60	45	33	35	34	33	39	62	75	70	76	66
14	59	44	35	35	34	33	40	62	78	71	78	65
15	57	42	33	34	34	33	43	68	78	69	76	60
16	55	40	33	34	34	33	45	54	77	69	75	64
17	53	39	34	33	34	33	42	53	76	71	76	58
18	53	38	33	33	34	34	40	54	74	71	76	57
19	52	35	33	34	34	34	41	54	73	74	76	56
20	53	34	32	34	34	34	40	51	71	69	71	55
21	50	34	33	34	34	34	40	51	73	69	71	56
22	47	33	33	34	33	34	41	59	74	71	71	55
23	46	34	32	34	33	34	41	56	70	72	68	55
24	47	35	33	34	33	33	41	53	70	74	68	55
25	45	34	34	33	33	33	43	54	67	73	67	56
26	43	35	33	34	33	34	44	55	70	74	66	55
27	44	34	35	34	33	35	44	54	70	74	68	54
28	45	33	34	34	34	35	48	53	65	72	70	53
29	48	33	35	34	34	33	44	55	64	72	69	55
30	50	33	34	34	—	34	45	59	70	70	69	57
31	52	—	35	34	—	31	—	62	—	71	69	—
Average	54	40	33	34	34	34	40	53	68	73	72	61

SUMMARY

The Grass River, formed by three branches rising in the lakes of the Adirondack Mountains, flows through large areas of Precambrian crystalline rock. The main stream then leaves the crystalline rock area, a few miles north of Canton, and flows through a narrow corridor of Cambrian sandstone. From Madrid and to the point where the Grass River enters the St. Lawrence River, the rocks consist of Ordovician limestones.

The mineral matter in the Grass River drainage area above and at Pyrites is of low solubility, and this results in relatively low ranges in values for dissolved solids and hardness of water. Although there are iron bearing minerals in the vicinities of Hermon and Pyrites, the concentrations of iron in solution are moderately low, ranging from 0.04 to 0.68 ppm. The low degree of pollution at and downstream from Pyrites appears to have exerted little or no influence upon the dissolved solids of the stream. Concentrations of solutes fluctuated moderately with streamflow. On the basis of the above chemical quality information, the water from the Grass River at Pyrites is good and can be utilized as an industrial, agricultural and public water supply.

Some information on the chemical quality of water from the river downstream from Pyrites is included also in this report. Additional information is being obtained during the current study and will be included in a subsequent report.

CHEMICAL QUALITY OF SURFACE WATER AT MISCELLANEOUS SAMPLING SITES IN THE ST. LAWRENCE RIVER BASIN

Other streams of the St. Lawrence River basin, in addition to the ones discussed previously, were selected for study. These streams are segregated in this report according to the principal river basins and are arranged in downstream order (Plate 1). Chemical quality of the water samples collected from the selected locations is represented by analyses shown in table 25.

A comparison of hardness-of-water ratios of the low - and high - flow periods, at different locations, reveals the variability of hardness of water throughout the Black River basin. Ratios at a few locations follow:

	Ratio of hardness of water at low and high flow
Black River at Greig, New York	1.9
Black River at Castorland, New York	1.0
Black River at Watertown, New York	1.2
Deer River at Copenhagen, New York	2.4

During the same seasonal period, the hardness-of-water ratio for the Black River at Watertown was comparable to that at Castorland. The higher ratios at Greig and Copenhagen may indicate that inflow of mineralized ground

Table 25.-Periodic analyses of water from streams in the St. Lawrence River basin

(Chemical constituents, dissolved solids, and hardness in parts per million, 1956 water year)

Source and Location	Date of Collection	Dis-charge (cfs)	Silica (SiO_2)	Iron (Fe)	Cal-cium (Ca)	Mag-nesium (Mg)	Sodium (Na)	Potas-sium (K)	Bicar-bonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evap-oration at 180°C)	Hardness as $CaCO_3$ Calcium magnesium	Hardness as $CaCO_3$ Non-carbon-ate	Specific conduct-ance (micro-mhos at 25°C)	pH	Color
Deer River at Copenhagen, New York	4-25-55	286	1.6	0.43	11	1.5	2.0	1.7	34	9.2	1.2	0.3	1.9	65	34	6	79.2	6.3	25
" " "	8-17-55	1/ 20	5.3	.34	22	3.2	2.4	1.1	71	--	1.7	.1	1.3	--	68	10	161	8.2	7
Black River at Greig, New York	4-25-55	5,100	4.5	.06	6.0	.5	1.4	.8	11	9.9	1.2	.2	1.5	45	17	8	41.2	7.0	28
" " "	8-16-55	738	7.4	.51	11	1.2	1.8	.6	34	--	.8	.0	.1	--	32	5	78.1	7.2	18
Black River at Castorland, New York	4-26-55	7,340	5.2	.03	5.2	.6	1.1	.8	10	8.1	.8	.0	.8	41	15	7	40.9	6.6	25
" " "	8-17-55	1,670	4.8	.44	4.2	.9	1.5	.6	14	6.2	.5	.0	1.0	31	15	3	40.2	7.2	15
St. Lawrence River nr. Alexandria Bay, N.Y.	2/ 4-26-55	--	1.5	.03	33	6.2	14	1.6	108	27	22	.1	.7	183	108	19	297	8.1	3
" " "	8-17-55	--	1.7	.10	38	7.9	9.1	1.3	113	24	21	.0	.7	170	128	35	301	8.0	5
E.Br.Oswegatchie River nr. Oswegatchie, N.Y.	4-25-55	1,840	5.0	.27	4.0	.7	1.3	.9	6	9.4	1.5	.0	1.5	36	13	8	36.1	6.6	25
" " "	8-18-55	115	5.0	.82	6.1	.8	4.6	1.1	18	--	2.4	.0	1.4	--	19	4	72.5	7.4	12
Oswegatchie River nr. Heuvelton, New York	4-26-55	4,010	4.1	.22	7.5	2.1	1.6	1.2	25	11	1.0	.0	1.5	57	27	7	67.9	7.1	30
" " "	8-18-55	496	4.3	.26	9.8	1.8	4.8	1.2	36	--	2.7	.2	1.3	--	32	2	101	7.2	5
St.Lawrence River at Odgensburg, New York	4-26-55	--	1.6	.08	35	1.6	12	1.4	104	22	9.5	.1	.4	160	94	9	278	7.9	5
" " "	8-18-55	--	2.6	.02	36	7.8	9.0	1.3	110	24	20	.0	.8	165	122	32	294	8.1	7
Grass River at Pyrites, New York	4-26-55	1,590	4.1	.13	4.0	1.1	2.0	1.0	11	8.3	1.3	.2	1.3	44	14	6	37.3	6.9	50
" " "	8-18-55	179	8.5	.40	7.6	1.8	1.2	.7	25	--	.4	.0	.5	--	27	6	65.3	6.8	28
Grass River at Massena, New York	4-27-55	2,060	4.3	.16	10	4.6	1.0	.6	39	12	1.0	.2	1.3	69	44	12	90.9	7.2	50
" " "	8-16-55	225	3.3	.16	12	4.8	2.2	.8	51	9.4	1.9	.4	.2	69	50	8	110	7.0	13
St.Lawrence River nr. Massena, New York	4-27-55	--	1.4	.07	37	6.7	11	1.6	109	26	22	.0	.6	192	120	31	290	8.0	2
" " "	9-15-55	--	2.2	.10	37	7.2	9.2	1.4	112	--	22	.0	.9	--	122	30	301	7.7	2
Raquette River at Piercefield, New York	4-25-55	6,720	5.1	.04	4.0	.5	1.0	.9	5	9.2	1.2	.0	1.2	32	12	8	28.7	6.5	22
" " "	8-18-55	282	3.5	.28	3.1	1.4	1.2	.6	8	6.4	.6	.1	1.1	28	14	7	34.0	6.3	8

Table 25.-Periodic analyses of water from streams in the St. Lawrence River basin (Cont.)

(Chemical constituents, dissolved solids, and hardness in parts per million, 1956 water year)

Source and Location	Date of Collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
															Calcium magnesium	Non-carbonate			
Raquette River at Raymondville, New York	4-26-55	7,190	5.2	0.04	4.0	0.8	1.4	0.8	9	8.0	1.0	0.1	1.1	39	13	6	36.5	6.5	25
" " "	9-15-55	1,650	1.0	.56	6.4	2.0	1.3	.6	17	9.8	.9	.0	.4	52	24	10	55.5	6.9	27
St. Regis River at Brasher Center, N.Y.	4-26-55	2,580	4.7	.12	5.6	1.5	1.4	.9	18	8.3	.8	.0	1.5	45	20	5	47.8	7.3	38
" " "	9-15-55	374	5.7	.57	8.8	3.1	1.4	.6	35	6.2	1.1	.0	.8	52	35	6	72.5	7.1	25
Deer River at Brasher Iron Works St. Lawrence, N.Y.	4-27-55	381	4.5	.14	11	3.1	1.4	1.0	43	9.0	1.2	.1	1.0	67	40	5	88.4	7.3	40
" " "	8-16-55	151	5.4	.43	13	4.1	1.6	.7	44	13	1.5	.0	1.3	75	60	14	107	7.5	40
Little Salmon River at Bombay, New York	4-27-55	155	6.2	.34	12	3.7	2.4	1.2	49	13	.8	.1	1.3	74	45	5	105	7.7	20
" " "	8-16-55	56.2	4.2	.21	18	6.0	1.8	1.1	60	20	2.0	.0	.9	90	70	20	148	8.2	12
Salmon River at Chasm Falls, New York	4-27-55	474	6.4	.35	4.8	1.4	1.3	.9	15	7.5	1.5	.1	1.3	45	18	5	41.3	7.5	35
" " " "	8-19-55	159	9.1	.46	8.8	2.6	1.4	.7	38	--	.4	.0	.8	--	33	2	76.7	6.9	23
Salmon River at Malone, New York	4-28-55	538	6.9	.14	6.0	1.3	1.2	.9	20	8.1	1.2	.0	1.0	48	22	6	52.1	7.1	35
" " "	8-15-55	204	7.2	.39	10	3.2	1.3	.6	40	7.0	.8	.0	.9	55	38	6	78.3	7.4	25
Trout River at Constable, New York	4-28-55	83.2	5.8	.35	9.1	2.6	1.5	1.0	33	11	.8	.0	.6	59	33	6	78.3	7.4	12
" " "	8-15-55	18.8	4.7	.12	19	5.7	2.2	1.2	72	14	1.9	.1	.8	90	71	12	149	7.3	7
Chateaugay River nr. Chateaugay, New York	4-27-55	347	6.0	.14	8.7	1.1	1.9	1.4	24	12	1.0	.2	.7	63	26	7	69.0	7.3	18
" " "	8-19-55	136	2.4	.06	12	2.8	1.5	.9	41	9.5	1.0	.0	1.3	55	42	8	91.2	6.9	8
N.Br.Great Chazy R. at Ellenburg, New York	4-28-55	75.1	4.7	.10	12	1.9	2.2	1.1	42	11	.8	.1	1.4	70	38	3	89.8	7.6	10
" " "	8-15-55	14.0	7.0	.08	20	4.6	1.8	1.2	71	11	2.0	.0	.3	89	69	11	146	7.7	10
Great Chazy River at Perry Mills, New York	4-27-55	544	3.4	.21	10	2.7	1.5	1.1	39	9.2	.8	.0	.6	61	36	4	84.3	7.5	18
" " " "	8-19-55	112	3.7	.09	13	3.0	1.2	1.0	49	--	2.2	.0	.8	--	45	5	103	7.7	2
Saranac River at Plattsburg, New York	4-27-55	2,090	5.9	.24	7.1	.6	1.2	.9	13	11	.8	.1	1.6	55	20	10	49.8	6.9	30
" " "	8-19-55	556	6.5	.50	11	3.0	2.8	.7	40	12	1.2	.1	1.2	67	40	7	96.4	7.4	12

Table 25.-Periodic analyses of water from streams in the St. Lawrence River basin (Cont.)

(Chemical constituents, dissolved solids, and hardness in parts per million, 1956 water year)

Source and Location	Date of Collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
															Calcium magnesium	Non-carbonate			
Ausable River nr. Ausable Forks, N.Y.	4-27-55	1/1,660	8.0	0.08	6.0	.7	1.8	1.0	12	11	1.2	0.1	1.4	56	18	8	47.1	6.8	15
" " "	8-19-55	407	9.0	.32	13	2.0	1.3	.5	23	--	5.2	.0	.2	--	41	22	88.2	7.2	37

1/ Daily mean discharge.
2/ The U. S. Board on Geographic Names, Department of Interior in October 1958 designated the East Branch of the Oswegatchie River as the Oswegatchie River.

water was greater in this section of the drainage basin than at Watertown.

An appraisal of available chemical-quality data indicates that the Oswegatchie River is of good chemical quality. The dissolved-solids content of the stream was very low. During the low-flow period, the dissolved-solids content of the Oswegatchie River was estimated from specific conductance to have been 81 ppm at Heuvelton, 66 ppm near Heuvelton and 47 ppm near Oswegatchie. Also, at low flow, the hardness of water was 19 ppm just above the confluence of the river with its major tributaries, 32 ppm near Heuvelton, and about 50 ppm at Heuvelton.

The bedrock at Oswegatchie, N.Y., consists of hornblende granite gneiss, whereas that at Heuvelton is composed principally of calcareous sandstone and sandy dolomite. The bedrock geology helps to explain the differences in the hardness of water and concentrations of dissolved solids in water at these locations.

Chemical analyses of high - and low - flow samples of water from the Grass River at Pyrites and Massena showed

that the river was of good chemical quality. The dissolved-solids content of the river at both locations was low. Low-flow samples at Pyrites and Massena had dissolved-solids content of 52 (computed from specific conductance) and 69 ppm and hardness of water values of 27 and 50 ppm (table 25). The difference in hardness of water from the Grass River at Pyrites and at Massena is due to the geology of the drainage areas. At Pyrites, the drainage is from a crystalline rock area, whereas at Massena the drainage is principally from limestone.

The chemical composition of the St. Lawrence River near Alexandria Bay and at Odgensburg and Massena was similar during low - and high - flow periods (table 25).

Other major rivers, including the Raquette, St. Regis, Salmon, Chateaugay, and Great Chazy in this area of the St. Lawrence, are also of good chemical quality. The dissolved-solids content of these streams is generally low, and the water is soft. However, more chemical quality data are needed to determine the changes in chemical quality as these streams pass from one geologic environment into another. Work to obtain these data is currently underway and will be discussed in a subsequent report.

CHEMICAL QUALITY OF GROUND WATER IN THE ST. LAWRENCE RIVER BASIN

A few chemical analyses were made of ground waters in St. Lawrence, Jefferson, and Franklin Counties. The data represent only the chemical quality of ground water already in use and merely indicate the chemical quality that may be expected in ground water from other sources in the same areas. For example, these data show that the hardness of ground water of the area may vary considerably. Water from limestone and dolomite deposits generally has higher hardness of water and higher dissolved-solids values than water from the sandstones and some other geologic formations (table 26 and 27). The chemical and physical qualities of the water vary from one well to another at some locations within the same rock area. Localized differences in mineral composition and in location with respect to recharge and discharge areas are believed to be responsible for these differences in quality.

Water from many wells in the basin contains varying amounts of hydrogen sulfide gas. The presence of the gas in these water probably is due to the reduction of sulfates in the presence of anaerobic bacteria.

Table 26.-Analyses of water from wells in the St. Lawrence River basin

(Chemical constituents, dissolved solids, and hardness in parts per million, 1956 water year)

1/ 2/	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (Calculated)	Hardness as $CaCO_3$ Calcium magnesium	Hardness as $CaCO_3$ Non-carbonate	Specific conductance (micromhos at 25°C)	pH	Color
								St. Lawrence County (Dolomite)												
1	October 24, 1955	48	18	0.08	0.02	97	54	16	8.7	366	140	45	0.1	0.4	559	464	164	911	7.6	3
2 3/	October 24, 1955	51	14	.11	.00	42	23	80	6.7	244	70	74	.6	2.5	453	200	0	754	7.5	3
3	October 24, 1955	48	1.3	.05	.04	168	44	380	12	102	584	530	.9	2.5	1770	601	517	3250	7.5	4
4	October 24, 1955	48	16	.08	.00	53	29	30	4.0	278	46	30	.5	.5	346	252	24	601	7.5	4
5	October 25, 1955	49	10	.14	.00	35	16	5.3	1.5	155	--	24	.3	.3	--	153	26	305	7.4	12
6	October 25, 1955	51	17	.54	.04	67	33	5.4	1.1	256	91	7.8	.1	.4	349	303	93	562	8.2	5
7	October 25, 1955	49	13	.50	.00	33	25	17	3.2	220	32	4.0	.5	.3	236	185	5	387	7.5	2
8	October 26, 1955	49	18	1.4	.00	20	33	49	2.8	316	26	3.0	.4	1.2	309	186	0	523	7.8	2
								(Limestone)												
9	October 25, 1955	48	12	.07	.01	70	34	4.1	2.5	300	63	6.0	1.8	1.3	343	315	69	570	7.8	2
10	October 26, 1955	49	14	.11	--	71	31	14	3.4	240	109	16	1.1	.2	378	305	108	604	7.7	2
								(Sandstone or Granite)												
11	October 25, 1955	49	12	.90	.06	64	24	13	2.6	236	70	14	.5	.4	317	259	65	520	7.6	2
12 4/	October 25, 1955	56	12	.09	.10	80	19	18	2.6	260	79	6.0	.3	.4	345	278	65	616	8.0	3
13	October 26, 1955	49	19	.51	.04	54	21	11	2.7	224 5/	45	14	.2	.3	277	221	37	449	8.3	2
14	October 25, 1955	55	11	.09	.04	85	25	9.1	3.0	307	53	12	.2	5.1	354	315	64	600	7.2	3
15	October 25, 1955	58	15	.39	.21	92	28	27	8.7	338	77	38	.3	4.8	458	345	68	755	7.4	3
								(Sand)												
16	October 28, 1955	--	14	.14	1.2	14	3.6	2.0	3.1	46	--	5.4	.0	2.0	--	50	17	137	6.7	2
								(Rock Formation)												
17	October 26, 1955	50	7.8	.06	.00	58	14	2.5	1.7	[illegible]	25	2.0	.5	.4	225	202	14	387	7.7	2
								(Potsdam Sandstone and Shale)												
18	October 26, 1955	50	12	.48	.00	32	34	21	3.5	210	74	12	.4	2.9	295	220	48	486	8.2	2
								(Bedrock Undefined)												
19	October 25, 1955	49	22	.10	.15	73	32	7.3	1.9	308	69	4.8	.2	.3	362	314	61	589	7.8	3
20	October 25, 1955	58	19	.06	.00	78	35	18	3.2	302	93	22	.4	1.1	419	339	91	673	8.0	2
21	October 25, 1955	55	15	.03	--	47	20	1.8	1.1	224	10	2.0	.2	5.6	213	200	16	368	7.7	3
22	October 25, 1955	55	14	.01	.01	43	22	3.0	1.4	202	29	1.5	.1	4.7	219	198	32	368	7.7	3
23	October 26, 1955	49	14	.22	.00	54	32	8.7	3.5	282	44	7.0	.3	.5	303	267	35	511	7.6	2
								(Glacial outwash (sand and gravel)												
24	October 28, 1955	50	1.4	--	.00	67	18	16	89	357	--	16	.1	16	--	241	0	767	7.5	18
								Jefferson County (Bedrock Undefined)												
25	October 27, 1955	49	4.9	5.1	.00	43	10	37	2.6	216	--	32	.3	1.1	--	149	0	474	7.5	90
26	October 27, 1955	49	13	.27	.00	77	27	17	2.9	340	--	13	.3	.8	--	303	24	672	7.3	2
27	October 27, 1955	49	10	.03	.00	86	11	10	2.2	263	--	17	.0	13	--	260	44	580	7.7	3
28	October 27, 1955	50	16	.18	.00	66	50	61	6.2	195	--	100	.3	3.8	--	371	211	968	8.1	2

Table 26.-Analyses of water from wells in the St. Lawrence River basin

(Chemical constituents, dissolved solids, and hardness in parts per million, 1956 water year)

1/ 2/	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (Calculated)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Color
																Calcium magnesium	Non-carbonate			
29	October 26, 1955	51	14	6.2	0.09	112	28	52	4.4	272	128	108	0.5	0.9	582	395	172	974	7.1	2
30	October 27, 1955	52	9.4	.13	.00	39	10	76	4.4	251	--	53	1.0	1.6	--	139	0	614	7.6	2
							Franklin County (Bedrock Undefined)													
31	October 24, 1955	47	20	.04	.00	31	9.0	4.3	1.0	109	22	7.0	.0	4.7	153	114	25	244	7.3	3

1/ See Plate 2 for approximate location of wells.
2/ Numbers refer to position in Table 27 - Well data.
3/ Hole is cut in casing, allowing water from dug well and drilled well to mix.
4/ Chemical analysis is for mixed water sample from 2 wells.
5/ Includes equivalent of 5 ppm CO_3.

Table 27.-Well data

1/	Type of Well	Depth (ft.)	Diameter (in.)	Water Bearing Material	Yield gpm	Location and Owner	Use	Remarks
1	Drilled	100	8	Dolomite	—	M.J. Fisher & Son Farm near Madrid, N.Y. (FN:ST7)	Domestic & Stock	
2	Drilled well in Dug Well	300	6	Dolomite and Till	50	R.L. Squires, Milk House of Homestead Dairies on route 56, 2½ miles S. W. of Massena, N.Y. (FN:ST 2)	Domestic	Hole is cut in casing allowing water from dug well and drilled well to mix.
3	Drilled	75	6	Dolomite	—	Village of Massena at Massena, N.Y. (FN:ST 4)	Mineral Springs	
4	Drilled	210	8	Dolomite	—	Village of Waddington at Waddington, N.Y.	Public Supply	
5	Drilled	316	7-8	Dolomite	400	Township at Norfolk, N.Y. (FN:ST 5)	Public Supply	
6	Drilled	30	6	Dolomite	—	St. Lawrence Paper Co. at Norfolk, N.Y.	Supplies mill and homes	
7	Drilled	173	—	Dolomite	—	K. Ashley at Chase Mills, N.Y.	Domestic	
8	Drilled	97	—	Dolomite	—	City of Ogdensburg at Municipal Airport on Route 87, ½ mi. S.E. of Ogdensburg, N.Y.	Domestic	
9	Drilled	203	8	Limestone (?)	—	DeKalb Creamery Inc. at DeKalb Jct., N.Y.	Domestic and Industrial	
10	Drilled	612	—	Limestone	—	Borden Co. at Gouverneur, N.Y.	Domestic	
11	Drilled	503	7.5	Sandstone	—	Raquette River Paper Co., at Unionville, 2 mi. E. of Potsdam, N.Y.	Drinking, Industrial and Cooling	
12	2 Drilled Wells	285 295	6	Sandstone (?)	300-325	Village of Norwood, N.Y. (FN: 14 and 15)	Public Supply	Two drilled wells feed together
13	Drilled	105	8	Probably calcareous sandstone	—	Western Condensing Co., Heuvelton, N.Y.	Industrial	
14	Drilled	200	6	Sandstone or granite	350	Village of Heuvelton at Heuvelton, N.Y. (FN:ST 13)	Public Supply	
15	Drilled	420	8	Sandstone or granite (?)	—	Potsdam Creameries, Inc. at Potsdam, N.Y. (FN:ST 16)		
16	Dug	—	—	Sand	—	State Conservation Dept. at Brasher Falls, N.Y. (FN:ST 40)	Domestic	Ground water observation well 16' in sand
17	Drilled	58	6	Rock formation	20	L. Wilbur (Marble Inn) on Route U.S. #11, 0.2 mi. S.W. of Gouverneur, N.Y. (FN:ST 27)	Domestic	
18	Drilled	153	4	Potsdam sandstone & shale	200	Ogdensburg Creamery, 30 Main St., Ogdensburg, N.Y. (FN:ST 8)	Industrial and Drinking	
19	Drilled	202	6	Bedrock undefined	66	At Canton, N.Y. leased by Queensboro Farm Products Inc., Long Island City, N.Y.	Drinking, Cooling and Washing	
20	Drilled	151	6	Bedrock undefined	—	Sheffield Farms Co., Canton N.Y. (FN:ST 20)	Industrial	
21	Flowing	25	—	" "	—	Ford & Watson Lumber Co., at Colton, N.Y.	Domestic	
22	Springs (?)	—	—	" "	—	Village of Hermon, N.Y.	Public Supply	
23	Drilled	148	8	" "	260	Sheffield Farms Co. of N.Y. City, Lisbon, N.Y.	Cooling, Washing, Boiling & Milk Plant	
24	GW Obser. Well	28	36	Glacial outwash (sand & gravel)	—	Leland Blevens at Hermon, N.Y. (FN-ST 392)	U.S.G.S. Ground Water Observation Well	
25	Drilled	225	6	Bedrock undefined	—	Stebbins Eng. & Mfg. Co., Watertown, N.Y. (FN:J 10)	Air Condition	
26	Drilled	475	8	" "	—	Crowley Milk Co. LaFargeville, N.Y.	Industrial	
27	Drilled	200	8	" "	—	Village of Dexter, N.Y.	Public Supply	
28	Drilled	253	8	" "	—	Dairy Mens League, 100 Park Avenue, N.Y., N.Y. at Chaumont, N.Y.	Washing and Boiler	
29	Drilled	220	8	Rock formation	—	Kraft Food Co., 3 mi. north of Theresa, N.Y.	Domestic and Washing	
30	Drilled	—	—	—	—	Northern Milk Corp. Adams, N.Y.	Cleaning & Washing	
31	Drilled	400	—	Bedrock undefined	—	Sheffield Farms at Malone, N.Y.	Cooling milk and ice	

1/ Numbers refer to position in Table 26 - Analyses of water from wells in the St. Lawrence River basin.

On the basis of available chemical-quality data, the ground water from these sources appearsto be suitable for most purposes if excessive hardness of water and concentrations of iron and manganese are controlled.

Plate 2 gives the approximate locations of the wells that were investigated.

CONCLUSION

WATER, QUALITY AND UTILITY

Generally, the chemical quality of surface water in the Lake Ontario and St. Lawrence Plains is as good or better than that of surface water in other areas throughout the state. The dissolved-solids content is as low as 28 ppm and the hardness of water is as low as 12 ppm in the surface water from some areas. Many of the streams have varying amounts of domestic and industrial wastes, but the direct contribution to the mineral content of the water is not known.

Because only a few chemical analyses were made of ground water in the area, a comprehensive appraisal of ground-water chemical quality is not possible at this time. The chemical quality data presented in this report represents only the chemical quality of some ground waters already in use and merely indicate what may be expected in the same areas.

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APPENDIX

GLOSSARY

Anion. A negatively charged ion.

Cambrian. A geologic period, which began, about 510 million years ago. It lasted about 80 million years. Rocks formed within this period are known as Cambrian rocks.

Cation. A postively charged ion.

Color. A visual effect due to material in solution and not due to turbidity or suspended matter.

Composite sample. A mixture of two or more water samples collected at different times (usually daily) at the same location.

Cubic foot per second (cfs). The rate of discharge of a stream whose channel is one square foot in cross-sectional area and whose average velocity is one foot per second.

Dissolved solids. Residue from a clear sample of water after evaporation and drying of residue for one hour at 180°C.

Hardness. Generally considered as the property of water attributable to the presence of alkaline earth metals of which calcium and magnesium are the principle ones. Hardness is expressed in terms of the calcium carbonate equivalent of the carbonate and bicarbonate content of water. The hardness in excess of this amount is called noncarbonate hardness.

Ion. An electrically charged particle, atom, molecule, or radical in which the charge is due to the gain or loss of one or more electrons and is accordingly, negative or positive in electrical sign, and equal in magnitude to the number of electrons gained or lost.

Ordovician. A geologic period following the Cambrian period. Rocks formed within this period are known as Ordovician rocks.

Oxygen consumed. A measure of the minimum amount of oxidizable material present in water.

Parts per million (ppm). Equivalent to one milligram of solute in 1 kilogram of solution.

pH. The negative logarithm of the hydrogen-ion concentration. Water having a pH value of 7 is considered neutral being neither acid nor alkaline. Values higher than 7 indicate increasing alkalinity and values less than pH 7 denote increasing acidity.

Precambrian. All geologic time existing before the Cambrian period. Rocks formed during this time are known as Precambrian rocks.

Runoff. The precipitation that appears in surface streams. This term also refers to the quantity of water that is dischargedfrom a basin as surface water. The amount

of surface runoff varies seasonally.

Specific conductance. The reciprocal of specific resistance. Specific conductance indicates the ability of water to conduct an electric current and is expressed as micromhos at 25°C. This property is related to the quantity and kind of dissolved mineral matter in solution and, within rather wide limits, is an approximate measure thereof.

Station. A suitable location on a stream where representative water samples are collected daily or less frequently.

Stream-discharge relation. The relation between gage height and the amount of water flowing in a channel, expressed as volume per unit of time.

Time-weighted average. An average computed by multiplying each concentration shown in the table by the time period it represents, adding the products of all values included in the average and dividing by the total time period.

Turbidity. The optical property of a suspension with reference to the extent to which the penetration of light is inhibited by the presence of insoluble material.

Water year. The 12-month period beginning October 1 of a year and ending September 30 of the following year.